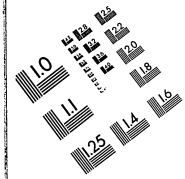

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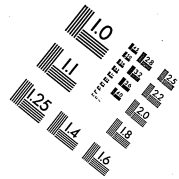

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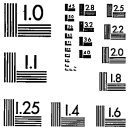
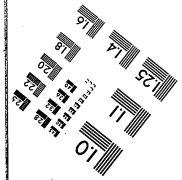
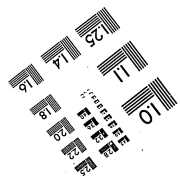
Inches







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PART II
(1879–1886)

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34

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THOMAS A. EDISON PAPERS

A SELECTIVE MICROFILM EDITION
PART II
(1879-1886)

REEL 34

NOTEBOOK SERIES (NBK-12)

Menlo Park Notebooks, #59 - #73

Menlo Park Notebook #59 [N-80-01-26]

This notebook has no dated entries but was probably used during 1879 and 1880. Most of the entries are by Francis Upton and relate to electric lighting. Included are calculations about the cost of central stations, conductors, and electric power distribution. There are also notes, drawings, and calculations about lamps, dynamos, and vacuum pumps, along with a few calculations by Edison relating to electric power distribution. The label on the front cover is marked "Upton." An index has been pasted onto the inside front cover. The book contains 285 numbered pages.

Blank pages not filmed: 236-241.

Missing page numbers: 1-4, 129-130, 132-139, 275-278.

Index.

Calculations — 113, 56, 57, 59, 61, 63, 65, 66
" { 69, 111, 122, 110, 111, 112, 114, 116, 117, 118 — 153, 15, 16, 18, 19, 196, 201, 202, 203, 204, 206, 207, 223, 224, 225, 226, 228, 229, 230, 231, 232, 233, 234, 235, 236

Dynamo — 188, 189, 190, 191, 192, 193, 199, 200, 205

Cost of Conductors — 25, 26, 27, 28

Cost of Electric Lighting — 157, 158, 159

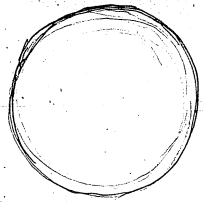
" { 120, 123, 124, 125, 127, 128, 129, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170,

No 57

Index.

Locomotive — 13, 56, 58, 59, 61, 63, 65, 66

" { 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50,



8

1 hour each day	year	
	365 hours	
2	730	2
3	1095	3
4	1460	4
5	1825	5
6	2190	6
7	2555	7

5 hours a day burning 5 cu. ft. an hour

25 cu. feet a day

1825
~~45~~
91.25 cu. feet a year

9 M. a year a burner

1460
~~5~~
~~5475~~
7300 7 M a year

five hours a day

9.12) $15.10 ($1.65
912
5980
5472
5080

$1.65 invested per M independent of land 5 hours a day

~~4 hours a day~~

7.3) 15.10 (2.07
146
500

$2.07 cts invested per M

12 Central station 10,000 lamps

2 Engineers	$6.	6
2 Foremen	$10.	10
2 ~~4~~ Wipers & Oilers $1.50	$3.	6
2 Regulators	$4.	4
per day	~~$25~~ $23	26

10,000 lamps 5 hours 5 feet

250 M per day

250) 21.00 (8.4
2000
1000

250) 260 (1.04
250
1000

~~$1. 8.4 cts per M~~

$26 10.4 cts labor

Coal under boiler $5.00 per 2240 lbs

13

3 lbs per H.P. per hour

)2240) 5,000 (.00223
4480
5200
4480
7200

.00223
3

$.00669 per H.P.

.000836 per lamp
200

.16 7200

16.7 cts per ~~hour~~ M

60 60

Waste & Oil

Say 1/4 that of coal

~~$1.25~~ 4.17 cts per M

~~Lubr~~ ~~Water~~ 1/8 Coal
2.08

Attendance	18.4
Coal	16.7
Oil &c	4.17
Water	2.08
	33.3 cts per M

running cost ~~34.3~~ 33 cts per M

Depreciation

		per lamp	per M
Engine	3%	.127	.016
Boiler	10%	.185	.020
Dynamo	5%	.20	.021
Conductor	2%	.10	.010
		$ .612	

61.2 cts per ~~lamp~~ lamp year

page 9

9.12) 61.2 (6.7
54.72
6480

6.7 cts per M depreciation

31.3
6.7
38.0 cts running expenses exclusive land and building

16 Land and Building

60000

$6000 a year

365 days
250 M
18350
730
91350) 600000 (6.5
554100
459000

6.5 cts ~~depreciation~~ Rent

31.3 Running Expenses
6.7 Depreciation
6.5 Rent
44.5 cts per M without interest 16.5 10%
61.0 cts for M inclusive

The light can then be sold at a price above that to pay for general management and patent rights

17

$10
$10
250
50
10 hours
10 hours
20
10 hours a day
Gasoline
$1.25
25
10 hours a day
10 hours
10 hours a day
10 hours
$10 10 hours a day
10 hours a day
10 hours a day

20 250 Cwo

10 Per Ht. P

~~1900~~ 1.3 =

Investment

See page 5 per M

Engine	.362
Boiler	.16
Dynamo	.348
Conductor	.547
	$ 1.417

Labor the same

10.4 per M

Coal	13.36 per M
Waste	3.34
Water	1.67
	28.77 per M

~~50 20 Two Shift Rate~~

Depreciation 15 per M

~~Dep~~ Engine	1.2 cts
Boiler	1.6
Dynamo	1.7
Conductor	1.
	5.4 cts

Rent the same per M 6.5 ct

	28.77
	5.4
	6.5
	40.67
Interest 15%	14.
	54.67 cts per M

Assume Boiler $20 in place of $15

$10 to capital
$1.00 to interest
$1.00 to depreciation
for H.P

Investment .27 per M

10 per H.P

2.7 per M in place of 1.6
1.6
1.1 added per M

8 per H.P

3.33
2.0
1.33 depreciation & interest
2.64 cts per M

44.5
~~4.45~~
~~49.95~~ per M at conversion
45.83 per M at conversion

Say $10 for Camp Conductor

$1.00 $1.09 invest per M
5.4 cts per M addition

Interest 8 per H.P.
1. ct per M depreciation
46.83 per M + $10 Boiler
47.83 per M

11.5 per Camp

10.8 per M interest Conductor
1.33
13.13
16.5
47.83
77.46 cts per M

$10

$ 20.000 for box
5 000 for ~ 1/4

700
700
700
700
450

33 50) 5000 (1.5
3350
1650

$1.50 for running foot

Cost of conductors

General laws.

The cost increases as the square of the distance from the central station.

1 Ohm may be taken as a fair estimate of the resistance of a conductor for 10 lamps.

1/10 of the energy will be lost in the conductor when all ~~over the~~ lamps are on

~~If~~ If a 200 Ohm lamp can be made in place of a 100 Ohm lamp the cost in a district will be 1/2 for conduc-

If two lamps of 100 ohms each be placed in series and also in multiple are the cost for conductors for both lamps will be 1/2 that for a 100 ohm lamp or for each lamp 1/4 that of a 100 ohm lamp

3 lamps placed in the same manner total cost $\frac{1}{3}$ each lamp $\frac{1}{9}$ &c

5 lamps $\frac{1}{5}$ $\frac{1}{25}$

Jan 26, 1880 do do do

Also for lighting street lamps theatres &c

too or the distance from the station may be 1.4 times as great so that the station will supply 2 times as many lamps with the same average cost for conductors.

To supply a district with 4 times the area each lamp will require 4 times as much copper in the conductor.

The cost of the box in which to place the conductor may be taken as for running feet

and ~~[illegible]~~ ~~the same~~ assumed

In table of conductivities, pure copper is assumed.

The cost per lamp in a given area is proportional to ~~its area~~ the size of the area

$\frac{5250}{1320}$ $\frac{750}{1000}$

Questions

How many feet of gas are consumed in various parts of N. Y. per consumer and an estimate of the average time of burning.

How much horse power is taken and the price paid per horse power up to ~~than~~ 10 horse power.

Cost of pipes laid in the street and depreciation

Cost of management

Cost of building lots or rent of same.

Cost of water per H. P. 83

Houses Estimated cost of introducing.

Cost of condensing as compared to high pressure engines

Cost of laying pipes or wires in the street.

$\mathcal{E}$ = Energy
$\mathcal{L}$ = light
$\mathcal{S}$ = Surface

$\mathcal{L} = \frac{\mathcal{E}^2}{\mathcal{S}}$

$\frac{1}{2}$ the surface

Nature. Twice the radiant energy from any surface gives four times the light from the same surface

The light increases as the square of the energy given off from the same surface

If the surface be halved keeping the energy the same the light will be doubled. There will be four times as much light given off per unit surface and only one half the number of units of surface.

The light from the same energy is inversely as the surface from which it is given off

To keep the light the same and ~~wants~~ yet have it given off from one half the surface will require $\frac{1}{1.4}$ the energy.

1/4 the surface and same light 1/2 the energy

That is since $\frac{1}{2}$ the surface give 2 times the light with the

same energy, and as the light varies ~~and~~ as the square of the energy it will take $\sqrt{2} = 1.4$ the energy

Keeping the light the same and diminishing the ~~energy~~ surface ~~varies as square of the~~ from which it is given, it will require an amount of energy which is as the square root of the ~~energy~~ surface

4

$$\frac{\mathcal{E}^2}{R} = \frac{(2\mathcal{E}_0)^2}{(2R)}$$

$$R\mathcal{E}^2 = \mathcal{E}_0^2$$

$$\begin{array}{r} 87 \\ 1.4 \\ \hline 348 \\ 87 \\ \hline 121.8 \\ 174 \end{array}$$

A 200 Ohm lamp to give off the same light as a 100 Ohm lamp with the same surface will require 1.4 times the E.M.F of a 100 Ohm lamp

That is if a 100 Ohm lamp requires 87 Volt a 200 Ohm lamp will require 121.8 Volts

---

A 400 Ohm lamp will require 2 times the E.M.F or 174 Volts

42

$\frac{1.4}{1.4}$ $L = f\frac{1}{S}$ $\left(\frac{S}{2}\right)$

$\frac{}{2R}$ $L =$

1.4 $\frac{1}{1.4}$

1461
.0730
.9270

$L = f\frac{1}{S}$

Erg²

$L = f\,\mathcal{E}^2$

$L = \phi\frac{\mathcal{E}^2}{S}$ Erg $= \frac{\mathcal{E}^2}{R}$

$L = \phi\frac{\mathcal{E}^4}{R^2 S}$

$L = \frac{\mathcal{E}^4}{2R\,\frac{1}{2}S}$ $\frac{\mathcal{E}^4}{RS}$

$\frac{1}{1.4}$ $\sqrt{1.4}$

9031
1461
1.0492

9395
0730
1.0125

So double the resistance and half the surface and still have the same light will require the ~~same E.M.F.~~ $\frac{1.4}{\sqrt{1.4}}$ the E.M.F.

1.18 the E.M.F.

.87 Volts 100 Ohm 1/1 = ohm
1.01 Volts 200 " 1/2 = "

11.2 per H.P.

A loop the same length and 1/2 the surface ~~will give~~ with 1/2 the material will give 11.2 per H.P. instead of 8

Laws

The best machine is that which with the least amount of energy consumed on the magnets will give the greatest E. M. F on the smallest resistance in the armature so long as the sparks on the commutator may be kept under. Interest on investment, friction and magnetic friction being made as small as possible.

The unavoidable losses are as follows

Energy

Magnet
Friction on bearings.
Magnetic retardation
Local action
Spark on commutator.
Friction on commutator
~~Defaro~~

Money

Depreciation
Commutator
Brushes
Belt
Bearings
Covering wires

The ~~[illegible]~~ cost of the magnets is ~~to have~~ when ~~the~~ the interest on the amount invested in them equal to the cost of the energy consumed in ~~them~~.

The ~~friction~~ of the bearings must be made as small as possible.

Magnetic retardation may be largely avoided by using very soft iron.

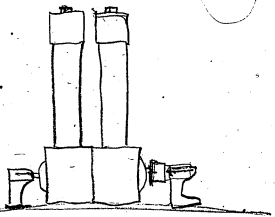
Local action is in ~~the~~ the Ehrion machine of no consequence.

$\frac{1}{50}$

$\frac{1}{50}$

Eou

Sparks on the commutator may be made very small by ~~removing~~ placing the brushes endways and widening the commutator



In winding the machine

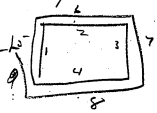
Twice the speed 1/4 the resistance

If the armature be made twice as long as now and have two magnets placed over it. One layer of wire will then do the work. The present machine may be taken as having 3/4 16 Ohm resistance.

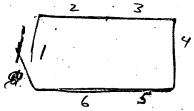
The wire in the new machine would be 3/4 as long

~~Over~~

Present



New



6/8 = 3/4 about

1/2 the resistance per foot

3/4 X 1/2 = 3/8 the resistance

2.75) 22000 (9.800 can be lost in
2020
1800
9.800

$3/8 \times .16 = .06$ Ohm resistance

$1\frac{1}{2}$ times the radiating surface as that ~~[illegible]~~ ~~the heat as times the heat~~

$1\frac{1}{2}$ times the heat may be given off from the machine

$(x)^2 \times .06 = 1\frac{1}{2} \times .16$

$x^2 = 1\frac{1}{2} \times \frac{8}{3} = 8$

$x = \sqrt{8} = 2.8$

2.8 times the lamps

$50 \times 2.8 = 140$ lamps

Say square wire

.042
3
126
.026
.152

073
2
.026

042
4
168
026
.194
.152
388
970
194
.029488

Cross section

314
.042
628
1256
.13188
.042
26376
42752
.0045396
.0113474

.001134
12
2268
1134
.013608

$\frac{3}{12}$

136)294(2
272
220

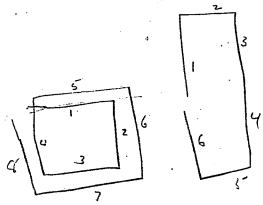
2.1 times the resistance in wound .042 than in square

.03 Ohm in machine

.03) 1000 (333

333 lamps each 100 Ohms and still 10 to 1 exterior to internal.

6) 1000 (166



3/4 the total wire

$\frac{3}{4} \times \frac{1}{4} = \frac{3}{16}$

20 inches diameter

2 times the present bore

2 times the surface

One layer sufficient as it will be twice as strong

2 times the surface

2 times the length of wire on ends ~~It is twice~~ the total wire

Each division 2 times as wide and twice as ~~thick~~ 1/4 the resistance

$3/4 \times \frac{1}{4} = \frac{3}{16}$ the resistance

E. M. F since the magnets are much stronger and the armature magnet must stronger Same speed of wire should give double the E. M. F.

That is half the speed of pulley

.03 Ohm

1.28
6
7.68

36
1.2
72
36
43.2

300 3 .12 Ohm

80

48 feet

300

100 1500 66

M

$3/86 \times .16 = .06$ Ohm
.03

.03 Ohms

2 times the mass of metal in magnets

1.24 times the diameter

$m = \pi L R^2$

$2M = \pi L R^2$

$= 1.2 R^2$

$R^2 = \frac{2}{1.2}$

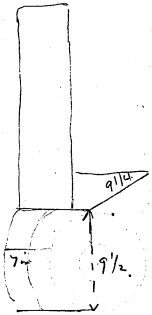
$R = 1.28$

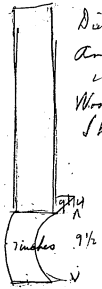
$(1.2)^2$ $(1.66$
12
8

0.2201
.101

Make magnet 7 3/4 inches diam

" " 3 feet 7 inches long





Diameter bore 9.75
Armature overall 9.67
" " minimum 9.19
Wooden core 6.25
Shaft 1.625

9 1/4 dead

9.19
6.25
2.94

19.5 × 3.14 = 61.2

1.2900 × .4969 = 1.7869 × .8751 = 1.911.8

.816

.042 + .013 = .055 × 6 = .385 × 4 = .02

2 / .816 = .408 × .385 = .023

.385 × 4 = 0

3.14 × 2

.042 × 4/20

.021
.021
.21
.42
.000441 = 1.6444

3.14 × .0.4969
3.2413 .00174
1.3802
24 .6215 .0418 Total Cir

.385 One division of 150 of circumference

.385 / 51 = .075
.013
.062

.013 × .062 / 4 = 2.02 .248

.0250
.000625

2.3979
2.3979
4.7958
4.7958
3.2820 .00174
1.7661
2.4818 .0390

Gas made from kerosene costs .66 cts. per M for material at kerosene 9 cts a gallon as now

This is from actual practice

Apparatus for 30 lights 4½ feet cost about $300.

Water power in quantities available

10000 lights from one station

	Horning	allowance
Belts	7.000	4666
Shafting	5.500	3667
Iron Structure	8.000	7000
Wood flooring &c	3.700	3000
5 Engines	42.500	42.500
Engine foundn	2.300	2.300
Boilers	20 000	20.000
Faradic Machines	36.000	24.000
	$125.000	$107.333
Conductors 55.00 per lamp		50,000
		157.333

90000) 157.333 (
1.725

$1.725 per M capital

Depreciation

Belts	10%	$ 466.60
Shafts &c	2%	77.34
Iron Structure	2%	140.00
Wood Housing	10%	300.
Engine	3%	1275.00
Foundation	1%	23.
Boilers	10%	2000.
Foundn Machine	3%	720
Total	5%	$ 5.001.94
Indirection	2%	1000
		$ 6.001.94

Power

Depreciation 6.6 cts. per M

Expenses

Labor

2 Engineers	6
2 Firemen	10
2 Wipers & Oilers	3
2 Regulators	3
Per day	$ 22
Per M	8.8 cts

Coal under boiler, includes Labor $3.50 for 2240 lb

$25.85 per day

10.3 per M

Water

Waste oil &c 1/3 Coal

2.76 cts per M

Rent $10,000

11.1 per M

Executive $11 per day

4.4 per M

Depreciation	6.6
Labor	8.8
Coal	10.3
Water &c	3.76
Rent	11.1
	40.56 Cts
Exec	4.4
10000	44.96
5000	

Delivered to Foreman

Spend $5.00 more on condenser and save in Investment

5% Engine
Boilers
Dynamo
Belts
Shafting save

Total plant 5% $ 5.265

Depreciation	5%	.33
Labor	0	
Coal	2%	.2 .075
Rent	0	
Executive	0	

per M annually .575

Total Capitalized 5.230
5.260
10.490

$10,500 can be spent to save 5%

$2,100 to save 1%

(105.00) 2.100 | 20 cts a burner to save 1%

1,00 a burner to save 5%

1250.
16 per H.P
7500
1250
$20,000

2 Stroke $6 per day

Dividend

50 cts per M		3%
60 cts per M.		9%
75 cts per M		17%
90 " " "		26%
$1.00	" "	32%

If 600 Horse power can be sold during the day for 10 hours.

The ~~Bonds~~ Amount invested the depreciation the labor and the rent would not need to be counted as they have been estimated on a basis of 15 hours a day wear.

The cost of coal and oil and waste are alone to be taken account of

Estimate of the cost of lighting 10,000 burners from a central station

It is assumed that a burner will consume the equivalent of 5 cu. ft. of gas an hour in giving ~~[illegible]~~ a light equal to that from 15 candles and burns on an average two hours each day

Tests show that eight such lights may be obtained from an indicated horse power in the belt

To furnish such lights 1250 horse power are required in one station

~~Burns hours a day = 25~~

A burner which is lighted
5 hours a day consumes
25. feet a day or about
9.000 cu. ft. a year
For convenience designate
1000 Cu. ft. 1 M.
10,000 burners in a year
will consume 90,000 M

Investment

Boilers & Chimney	20.000
5 Engines	42.500
Foundations	2.300
Iron Structure	7.000
Shafts &c	3.900
Belts	4.700
Wood flooring	3.000
Faradic Machines	24.000
	107.400
Conductors	50
Total	157.400
per M	$1.75

Depreciation

Boiler	10%	2.000
Engines	3%	1.275
Foundation	1%	23
Iron Structure	2%	140
Shafting	2%	77
Belts	10%	466
Wood flooring	10%	300
Tandem Machines	3%	720
		5.001
Conductors	2%	1.000
		6.001

per M 6.6 cts

2240

8.45
8.4
4225
2535
29.57

1250
15
6250
1250
2240) 17500 (8.45
17920
8300
~~8960~~
~~1400~~

8.37
3.15
42285
2511
29.39

6.30
672
1560

Expenses:

Labor (Stoking included in coal)

2 Engineers	6
2 Foreman	10
2 Wipers	3
2 Regulators	3
	$ 22

per M ~~$1.17~~ 8.8 cts

Coal. Dust coal is taken at $3.50 a ton under the boiler so as to include wages of stokers. 3 lbs of coal an hour is required to ~~[illegible]~~ give a horse power

8.4 tons ~~$29.39~~ ~~[illegible]~~ per day

11.756
~~10.3~~ cts per M

Water &c 1/3 coal

~~2.43~~ cts per M

3.91

Rent $10,000 a year
11.1 cts per M

Executive
1/2 labor — $11 a day
4.4

Summary Per M

Depreciation	6.6	cents
Labor	8.8	
Coal	10.3	
Water	3.8	
Rent	11.1	
Executive	4.4	
	45.0	cts

It costs 45 cents per 1000 feet delivered to the consumer for Electricity.

Dividends

Sold at 50 cts per M	3 %
60 " "	9 %
75 " "	16 %
96 "	25 %
$ 100 " "	31 %

If for 10 hours during the day 400 horse power could be delivered at the consumers at a cost of 600 at the station and with an investment of $12.500 for additional conductors, at 50 cts per M a dividend of 17 % could be earned.

In making this estimate it was remembered that the wages, depreciation were calculated as fully paid by the light for a day of

15 hours. This leaves for cost of power only the coal and water consumed.

200 H. P. sold at 50 cts per M
200 " " " 60 " " "
100 hours Light 60 " "
Dividend 25 %

200 H. P. sold at 50 cts per M
200 " " " 75 " "
Light " " 75 " "
Dividend 40 %

200 H. P. sold at 50 cts per M
100 " " " 75 " "
100 " " 90 " "
Light 90 " "
Dividend 49 %

200 H. P. sold at 50 cts per M
100 " " " 75 " "
100 " " " $1.00 " "
Light " " $1.00 " "
Dividend 56 %

It should be considered that the light is far better than gas, and can be sold at a higher price than gas and pay profits.

For example

In New York today

Preliminary Estimate of the cost of lighting 10,000 ~~of~~ Electric burners from a central station ~~equal that from~~ giving a light of sixteen candles, or taking the place of a gas jet consuming 5 cu. feet an hour.

Five hours use of each burner is assumed as the average for the year. In taking this figure it was remembered that during the day a large number of lights are used in dark rooms and during the night a still larger number are used ~~through the whole night~~ from ~~to~~ eight to twelve hours

A gas jet which consumes 5 cu. feet an hour burning ~~for~~ five hours each day will consume 25 cu ft. in that time, or about 9.000 cu feet in a year. in making comparison with gas

For convenience ~~designate~~ the electrical equivalent, ~~or~~ that is the amount of electricity which will produce the same ~~amount of~~ light as ~~from~~ ~~gas~~ 1000 cu feet of gas, as here designated as M

For example an electric burner is said to consume 9 M a year, or 10,000 burners 90,000 M a year.

Tests show that it is possible to obtain 8 lights from one horse power carried by the belt, so that for 16,000 light 1250 horse power will be required

1. Investment

Boilers & Chimney (From Babcock & Wilcox estimate)	21.000
5 Engines Holly estimate	42.500
Foundations	2.300
Iron Structure	7.000
Shafts pulleys &c	3.900
Belts	4.700
Wood flooring &c	3.000
Water heater & pumps	7.000
Iron floor and supports Boiler	6.000
Dynamo Machines	24000
Conductors	50000
	171400

Total investment per M $1.90

Treasury 20,000 shares

100,000 shares
80 000

24,000 shares

$\frac{24}{100}$

80000 shares

30,000 shares to owners

5000
20000 to treasury

30000

62500
24000
38500

10000	Edison	5000
10000	[illegible]	5000
10000	[illegible]	5000
4500	[illegible]	3600
1875	Lopez	1475
875	[illegible]	675
750	[illegible]	500
250	[illegible]	200
250	[illegible]	200
		30340

38500) 30000,0 (.78
26950 0
3050 00
3080 00

.78
45
390
3120
35100
14000
13260
1452 00

7800
7800
7800
3510
1432
672

385) 300.0 (7
15

2.4771
2.5555
1.8916

.779

[illegible]	7785	7791
[illegible]	7785	7791
[illegible]	7785	7791
[illegible]	3507	3508
[illegible]	1460	1460
[illegible]	681	682
[illegible]	584	585
[illegible]	195	195
[illegible]	195	195

29977 . ~~29998~~ ~~30000~~

29977 instead of 30000

.23

4500 — 3.6532 − 1.8916 = 3.5448

1875 — 3.2729 − 1.8916 = 3.1645

875 — 2.9420 − 1.8916 = 2.8336

750 — 2.8757 − 1.8916 = 2.7667

250 — 2.3979 − 1.8916 = 2.2895

300
385

4771
5855
1.8916

250
250
125
30
62500

83.3 Volts

220
220
44
44
484

73.3

62:48

48:62!!

73.3
73.3
2199
2199
5731
53 289
24.
21488
21488
2363.6

2364 ft. lb.
3031 ft. lb.

2364) 33000 (14
2364
9360
9456

83.
83.
249
664
6889
44
27556
27556
303916

70
70
4900
44
19600
196
2256.00) 33000 (14.6
2256
10440
9024
14160

205
68.3
68.3
2049
5464
4098
4664.89
44
18656
18656
2052.00) 33000
2052
12480
12312
2360

15.1 per H.P.

Depreciation &c

Boilers & Chimney	10%	$2100
Engines	3%	$1275
Foundation	1%	23
Iron Structure	2%	146
Shafts pulley &c	2%	77
Belts	10%	470
Wood flooring &c	5%	150
Water heater, pumps	5%	350
Boiler floor	2%	120
Faradic Machines	3%	720
Conductor	2%	1000
		56.425

Depreciation M annually
7.14 cts

Taxes 2%
3.8 cts per M

3 lbs an hour
15 lb. day

It is recommended that a small amount be charged yearly for coal burner, enough to pay for breakage and attention.

2240 lbs. to a Ton 3.50

3.441
3.3502
3.1939
15 1.1761
12.50 3.0969
1.4669

$.00156

$29.30 a day for coal

4
$117.20

Expenses

Labor (Stoking included under coal)

Per day	2 Engineers	$ 6.
	2 Foremen	10
	2 Wipers	3
	2 Regulators	3
		$ 22

Executive may be taken as about 1/2 of this or $11

$33 per day

or 13.2 cts per M. Total

Coal

Dust coal is taken as costing $3.50 a ton under the boilers that is including labor of stoking.

3 lbs of coal an hour are required for one horse power.

$29.30 for coal a day

11.7 cts per M

20000/10000
11.1

Water for boilers waste oil &c
Estimated as costing 1/3 of
coal 3.9 cts per M

Rent $10.000 a year for
the cellar and first floor
of a building 100 X 50 feet
in any locality near the
place where required
11.1 cts per M

Summary

Depreciation	7.14
Labor	13.2
Coal	11.7
Water	3.9
Rent	11.1
	47.0 cts per M

That is the cost of the light delivered to the consumer will be 47. cts per M

		47.0
Taxes	7%	3.8
Insurance	1%	.48
		51.3 cts

3
190 .4771
2.2788
1.983

1.25
.47
.98

1.8921
2.2788
.6133

13
190 1.1139
2.2788
2.8351

~~2.0969~~
~~2.2788~~
~~.8181~~

28
190 1.4472
2.2788
1.1684

2.1261
2.2788
.8973

43
190 6235
2788
13547

150
47
103
2.0123
2.2788
.7335

54
190 1.7634
2.2788
1.4846

Selling light alone

The dividends will be

At 60 cts per M		1.5 %
" 60 " " "		6.8 %
" 75 " " "		14.7
" 90 " " "		22.6
" $1.00 " " "		30.5
" $1.25 " "		41 %
" $1.50 " "		54 %

204) 280 (13.7
204
190 760
612
1480

204) 1070 (5.2
1020
800

600 H.P. 50 cts

a 1 H.P. delivered
1½ H.P. in elevator

1.5 X 8 X .5 = 60 feet per hour

$\frac{1000}{60}$ = 16.6 hours per M

16.6
5 cts for 60

16.6
8.30

Power estimate.

It is estimated that 400 horse power can be sold during the day for various purposes, small shops, elevators, lathes, sewing machines, pumping.

10 hours average use of this amount is assumed.

The cost will be simply the cost of coal under the boilers and water &c. $12.500 will have to be invested in conductors additional. ~~Possessor~~

Power is sold today in New York at $150 a year or 5 cts. an hour. or at the rate of 8.3 cts per M. Electric power has this advantage it does not cost when not used

2% 12.500 — 125.00

.02

2 50.00

125.00 — 27

13.9 cts. to invest per M

1 H.P. sold

cost 1.5

8 lbs coal

.64

.00156

9

.01404

1.4 cts

.00156

624

936

.01404

.43

1.83

27

2.00

91

27

1.18

50 cts per M

.05 per unit

60

.05

3.00

1.18

1.82 profit

16.6 cts per M

cts an hour

H.P

1.16

At 50 cts a M light & power

	additional income	Total
	11 %	12 %
at 60 cts M light & power	14 %	20 %
at 75 cts a M light & power	19 %	34 %
at 90 cts for light and 200 H.P. 75 cts for 200 H.P	22	45
at $1.00 for lights and 200 H.P 75 cts. for 200 H.P	24 %	54 %
at $1.25 for lights and 200 H.P. 75 cts 200 H.P	28 %	69 %

4

69

	Additional	Total
At $1.25 for lights and 200 H.P.		
1.00		200 H.P.
	33 %	73 %
at $1.50 for lights and 200 H.P.		
1.00		200 H.P.
	38 %	92 %

204) $53 . 26
4046
1220
26

26
33
59

Ver
24 hours a day

Depreciation	12 cts per M
Expenses	20 ~~cts~~ " M
Coal	15 cts " M
Water	5
Rent	22
	74 cts per M

$3.80 per M
five hours a day power

10 . 3.80) 26.0 (8.

380) 26.00 (7 %
~~2.80~~
2.60

$1.00 a thousand 7 %

Power 400 H.P. a day

2240) 3500 (.156
2240
12600
~~1 440~~
1 4200
14000

.156 cts per lb of coal

156
9 lbs
1404 at 1 3 H.P.

.702 per 1½ H.P.
.23 water per
.93 Per H.P.

1.18

156
3
468
156
.624

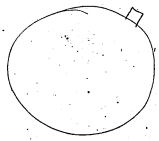
40 feet
= ~~25~~ M

~~31.200~~ per M

624) 31200 (50
15.6

After depreciation

Cost per M 15.6 cts per M



3

Estimate

Taxes 2%
Insurance 1/4 %
Patent right 1/3 capital

125 00
3
100.000

11.7
3.9
15.6

Taxes 1.90
.02
.0380

additional for patent right
1.90
.63
$2.53 per M

Suppose a station for lighting street lamps average use 10 hours a day

10 lamps in series 10 per H. P.

10000 lamps

1000 H. P.

Night service alone

Rent $5.000 a year

Coal $3.00 under boiler

~~$1.~~ 2 lbs. per H. P.

Engine $65 a H. P.

Boilers 1/3 less than in other estimate

1/2 for future

$21 invested

Engines $65.000

Boilers for 1250 H.P. cost $20000
1000 will cost $16000

	5333
Boilers	$ 9.667
Shafts	3867
Belts	4666
Iron Structure	7000
Wood flooring &c	3000
Engine foundation	3000
Faradic machines	24000
Conductors	20.000
	65.533
Boilers	9.667
Engines	65.000
	140.200
Lamps 25	2.500
	142.700

$14 per lamp invested

Cost of running

Labor $14 a day

365
14
1460
365
$5110 a year

Coal 2 lbs. an hour

1120 H.P an hour

Say Ton of coal to run engine an hour

10 tons a day

3650 ton a year

3.5
18250
10950
$12775.0 Coal

2129 Water

Russia

Austria

Germany 250

300 France 300
300
00 3000

Belg. 240
370
Spain 2600

Italy

237 10
3.00 300
3000
711

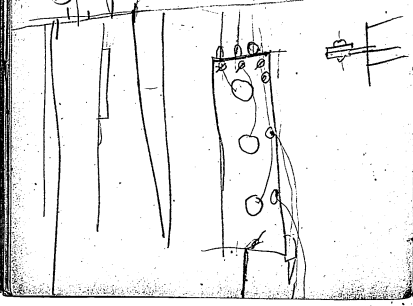
230 232 233 1/3
3 3
690 696 99

03

.33

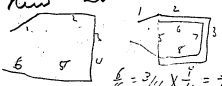
100
100
10000
44.3
443000
3

33 | 13290.00
44.3 H.P. ~~to~~ 20 to 1



Elim

Here 20 inch



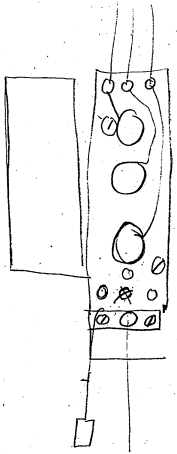
$\frac{6}{8} = \frac{3}{4} \times \frac{3}{4} = \frac{9}{16}$

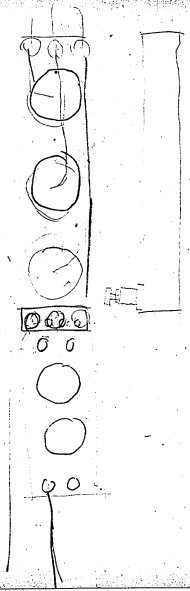
$\frac{9}{16}$ of the resistance of the 10 inch

2 times the surface

$x^2 \times \frac{9}{16} = 2$

$x^2 = \frac{2 \times 16}{9} = \frac{32}{3} = 10.86$





3/16 the resistance
2 times the surface

$(xc)^2\ 3/16 = c^2$

$x^2 = \frac{16}{3} = 5.33$

$x = 2.3$

$\sqrt{5.33}$ (2.3

$\sqrt{1.33}$ (.4

2.3
1.4
92
23
3.22
50
161.00 Lights

161 Lights same heat per unit surface

150) 100.0 (.666
900

.03) 66
22

150 light 22 to 1

1 1/2

.005

.005
3
.015

1.5
.015
75
15
.0225

3/16

.20 .20

$\frac{2}{10}$ $\frac{1}{5}$

$\frac{22}{1000} = \frac{11}{500} = \frac{1}{45}$

$\frac{1}{1.4}$ 3000

1.4) 3000 (2150
28
22
14
70

√2 1.4

3000 ft. lbs to give 16 candles

1000 ft. lbs

1500
21

$\frac{1}{4}$
200

1 mech
1/4

150
3
450
2
36) 900
~~30~~
36

Zohfle for A.P.

A Dynamo machine giving 90 Volts E.M.F. with 75 coils of two layer each.

$\frac{90}{75 \times 2}$ = E.M.F on one wire laid across face

150 | 900 | .6 Volt
900

.012
.012
.000144
443
432
576
576
.006 3792

.00063 On Ohm

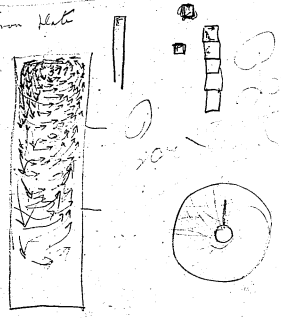
$\frac{1}{1000}$ ohm

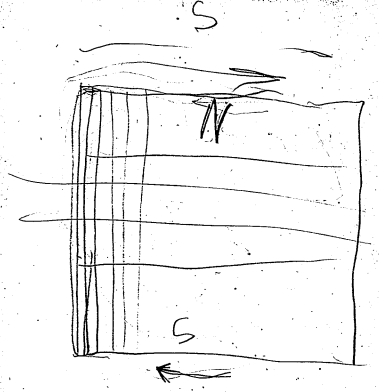
6.3 ft. lbs $\frac{1}{1000}$

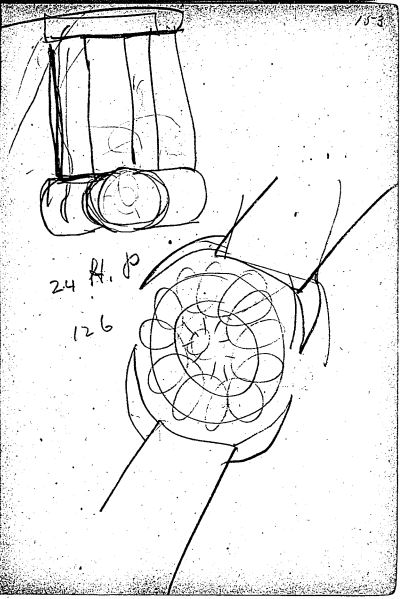
63. ft. lbs $\frac{1}{10000}$ Ohm

630 ft. lbs. $\frac{1}{100000}$ Ohm

Iron plate




S
N
S


24 ft. p
126

4 Machines

$\frac{1}{8}$ H. Power

On 100 Ohms

Make magnets from total resistance

25 Ohms

On each machine make $\frac{25}{4} = 6.25$ Ohms

Present machine

1.7 Ohms on magnet

1/2 area

$$\begin{array}{r} 1.7 \\ 4 \\ \hline 6.8 \end{array}$$

Wind magnets with six layers of wire 1/2 the cross section of present magnets

Estimate

Or. The present .14 Ohm machine with heats more running without any ~~lights~~ current being taken from it than the round small wire .56 Ohm does giving 20 lights. It is reasonable to suppose that that is equivalent to 40 lights taken from the .14 Ohm machine. The machine should run 70 lights with safety ~~to~~ but heats with 30 lights badly

Cost of machine
$200

Since by doing away with the heating $\frac{4}{3}$ more lights can be obtained

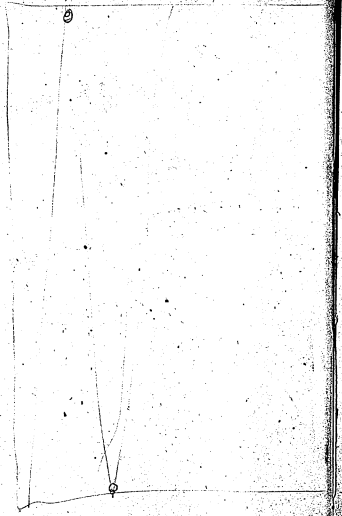
$\frac{4}{3} \times 200 = \$266$

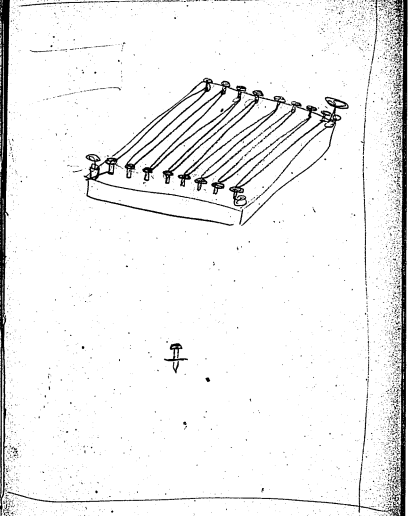
$266 can be spent on the armature to save ~~that~~ the heating

Since the energy lost is .4 of a horse power
1 ct per hour
~~10~~ 4 cts a day 10 hours
365
.04
$14.60 cost for horse power
$146 capitalized
146
266
$412 can be spent on armature

Kreerie estimate
$25 as the additional
cost of small iron
square wire.

Mining Engineer
Mining Engineer
Apache Grande
Mining New Grande
Gold Mining Co.





1st measurement

off pump 242

2186 1/3 foot lbs — R. Cald 234.

Corrected for 10 alum R German S – 2056.

Upton made error in measuring resistance

new measurement — More than a gas jet

2359 foot lbs

fourteen per horse power

2nd Lamp. gas jet 21 1/2

per hp. R off pump 350 after burning 2 hours 390.

2186.
130
2056.

Gordon

Balbo
Balboa
b
Balboa
Balboa
Balboo
Balboa

90
90
8100
44
32400
32400
356400

163) 2186 (13
163
556.
2489.
67.

Centenarian

163) 356400. (2186 5/8
326
304.
163
1410
1304
1060
978
82
8
246

2180
15
10900
2180
3270

1520
20
30400

1520
22
3040
30400
33440

134) 356400 (2659
268
887
804
800
670
1300
1206
Portland, Portland Portland

134) 2659 (19
134
1319
1206
113

20
2659
2359

2359
14
9436
2359
33026

220) 356400 (1620
220
1364
1320
440
440
00

220) 1620 (7 1/3
1540
80
00

15
7
105
1

1620
110
1520

225

55 Ohms No 683
21.7
343 Ohms Resistance

75 Ohms

225 : 165 : 75
75
825
1155
225) 12375 (55
1125
1125
1125

91.66

55 : 34.3 : : 91.66
343
27498
36664
27495
55) 31439. (57.1
275
393
385
89

34.3) 1439300 (4196
1029
1372
673
686
343
3300
3087
2130
4196) 330000 (78
29372
36280

No 696 150 Bastfibre

150 : 165 :: 75

75
825
1155

150) 12375 (82 Ohms
1200
375

82) 372000 (4536
328
440
410
300
246
540

4536) 33000 (7.3
31752
12480

No. 695 Twisted fibres

130 : 165 :: 75

130) 12375 (95
1170
675

95 Ohms

95) 372000 (3915
285
870
855
150
95
55

3915) 33000 (8.5 per 14. P.
31320
16800

263
87
87

No. 696

135 lamp

150 Resistance

135 : 150 :: 75 :

150
350
75

135) 1100 (81 Ohms
~~9450~~
1080
200

24.5
24
576

30
900

No. 700

215 75 Ohms

180 lamp

180 : 215 :: 75 :

75
1075
1505

180) 1612.5 (89.5
1440
1725
1620
1050

Mr Line

Soda = 0

11° 30' R = Lead

7° L Lithium

5° 15' } Green line
2 int 8° } Unknown

10° 3/4 R Strontia

T: 14: 361
11
361
361
7 3971
1567

115 R Lead

7 L Lithium

11 L Strontia

D lines 1002.5 mm
1006.5 mm

Lithium 644.5
Strontium 3615

L.

100.2
89.5
10.7

7 : 10.9 :: 107
10.9
963
107
7) 116.63
16.6
10.02
1168

~~23~~ 27.5

1005
645
365

~~28~~
~~19~~
32

50

31.

18.

7 : 10.9 :: 19 : 28
18
872
109
7) 1962
28

109° Between Bithun and Na
365 Bunt other " " Na

~~109~~
365 : 109 :: 18 :
18
872
109
1962

365) 1962 (5.3
1825
1370

4.25 4.25
19.25

110 : 365 :: 4.25

4.25
1825
736
1460

110) 355.25 (14
110
45

~~4.25~~

7 : 10.9 :: 110
110
1190
109
7) 1199
171

1005
171
1176

6 8
5 14
50

1750 lb
1000 na
750

10.9 : 5.25 :: 750 :
750
26250
3675
109) 3937 50 (361
327
667
54
130

1361 6) 8 4 4
6 4

6 8
1 44
4 0 24

~~5 0 30 6~~

8° 28' L Lithium
6 8 L Sodium
2 20

10° 20' R Strontium

8
60
480
28
468
368
100

6
68
368
80
448

60
80

10° 44' L Pt points in reversion

5° 18' L " "

6° 12' Sodium

100 : 448 :: 19

19
4032
448
8512

360

100 : 264 :: 360

360
15840
792
9540

1005
950
1955

19 : 56 :: 360

32
2160
180
19 | 20160 | 1061
19
116
114
20

1005
644
361

100 : 448 :: 361

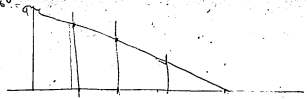
361
448
2688
1344
617.28
1005
2622

10 44
60
104

36 8
104
264

100 : 264 :: 19 :: 50

19
3376
264
5016



252

```
     200
    440000
    40000
   1760000
```

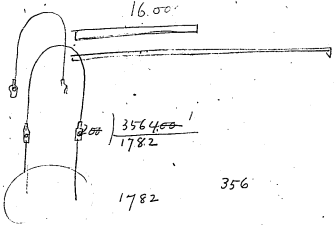
```
     252
     252
     504
   1260
   504
   635 04
   44
   2540 16
   2540 16
   27 9416
```


5 2 4

25

$2\frac{1}{2}$ 200, 8

16.00



```
356400 1
1782
```

1782 356

1600.

```
356400
2851200 (178
16
125
112
137
128
32
```

2851200

```
200
200
41000
4
40
40
420000
00
640000
640000
7040000
```

182

800

0

3200

253
253
759
126 5
506 9
6425 9
44
2560 3.5
2560 36
3200 / 2561.6 3 / 256
25 6
22
323
288

183

2

90
40
5400
44
32400
3240 8
200 / 3564
7200
1780

3600 . 16 = 4
1500
1440
5

7 175 175 675 1223 175 3062 44 12250 12250 / 1347.5 128 64 3

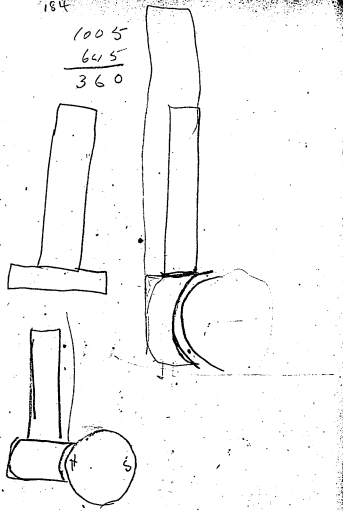
17. 16 16 17. 1421

1281

1284

185

1005
615
360



18.

105
50
55

Lithium 4° 25' R

Na. 2° 9' R

L. 4° 22' R

Sr. 5° 6.5 L

4° 25
2° 9
2° 16
120
136

2° 9'
5° 6.5
7° 15.5
60
420
15
435

Sl

10' L

2°9°
120
129
10
139

1° 59
60
119 m

139 : 435 :: 77

77

3045

3045

139) 33495 (08

238

969

139) 334

1° 5' L.

1505 : 2726

505 : 1726 :: 139

139

15534

5178

1726

505) 239914 (4 0317

220

1990

1515

3750

in plane 435

1° 44' L was over one line

Na 608

1 44

422

240

262

2020

5° 18

00
300
18
318

6 8
5.18
50

Clamps

Two lines

A 2° 6' L 5 || Rt

4° 58' L 2

1° 23 R

	A	B
	1° 52'	3
	3° 33'	3
	3° 41.5	3
	3° 44.5	2
	4° 56	3
	5° 2	4

~~Na 2° 18'~~

6° 5 5' L

3° 9 R Na

4° 6' R

3° 5 L

2 18 || Two lines

2° 9
2° 6'
4 15
60
240
15
255

5° 2
2 6
7 8
6
42
42 8

Lamp 727.
Fibre held in paper clamps

R = 169 Ohms cold
= 83.5 hot

2381 ft. lbs
14- per. H.P.

Gas jet

2 42
5 12
7 59

= 2° 43'.5 R. Na lines
2° 42'

5° 17' L Sr

Na 0 7° 31 Na L line
Sr 7° 33 R Sr
Sr 35 R Strontium

Li ~~30 20~~ L 3° 20' ? ~~Lithium~~ ?
2° 18'
~~[illegible]~~ Lithium

7
30
420
33
455

150
20
200

~~Lithium~~ 2° 18'
138

O Potassium

Lead impure
Edison

Na = 0

150 24 174 2° 24' R Ultra Red

15 1° 5' L Exceeding bright 10
Huggins 1240 Nebulous

81 1° 21' Very bright .7
Huggins 1279 Great grouped lines

20 8' Like last
128 Huggins 1479

4° 2'
242

40 18.5 Middle between
255 two lines shaded
Huggins 1960.5 10 wider than D lines
1965.5
Nitrogen

70 16' L
60
430
160
490.5

9 56' Very bright also
540 3329 Nose
576

10° 49'

Sodium nearly O
Tin impure

13' R Another line at side
948.5 ~~wide~~ nearly as bright more
1000.5 Nebulous looks like
Tin Rodium lines enlarged

1° 42' R Strong line
192 648 Sn

20.5 L Very bright
Huggins 1978 Sn
1145 47 Very bright

1° Very thin bright line
1219

10 16' Strong nebulous
1260

1° 19' Twin with last
1284

120 2° 22'.5 Bright nebulous
2.5
142.5 line
1524 Sm

4° 21' Center two lines
261 1960.5-10 like D lines
N 1969

7° 19'.5 little brighter than
439.5 a great many lines
N 2669 in vicinity

8° 23' Thin bright line
484
3
503 2797 standing alone

9° 14'
540
14
554

Raynor "Rt."
Nebulous
121 R Bright

55'.5 R Big nebulous spread
No 805 N. out line.

10° 44'.5 R Thin red line
8
104

10° 59 Nebulous red
~~Sharp Nitrogen~~ Thin red

2° 4'.5 Thin "
124
5835.5 Nitrogen

10 h Center two thin
10641 S S lines exactly as D lines
10645 S S not bright
Pr

~~10 h~~

39.5 L Thin bright line
n 1118'
46.5 Thick " "
52' Thin bright line
2° 33' Thin stand bright line
1535
3° 15' Thick band not
1955 very bright
40 20' Centre
0 12785
0 1499
7° 19'
420 n 2669³
439

Johnson Mathay Rf. 199

9'
8' Like bright L line

55' Band like not
n 0 8072α very bright
Thin line
1045' Thin lines
1° 59'
2° 3 Thin lines
42' L. " "
48' Strong line remember
51' Thin

3° 16.5' Wide band not
very bright

40 4' Thin band

40 21'. Centre two lines

6° 42' . Thin line

7° 22' Bright line near a great many other lines nearly as bright

~~7° 22' R~~

40' R

73 : 367 :: 18.5

185

1835

2936

367

73)67895 (93

657

219

133

73

65 : 240 :: X : 105-6

65)240 (37

195

450

455

56

37

392

168

20.72.

142.5)524 (364

4275

9650

8950

7000

365

674
365
3370
4044
2022
60 246.010
Rd 3° 6'

479
365
2395
2874
1437
60 176.835
2° 56'

365
29
3105
730
10405

161

273
161
273
1638
273
1439.53

20 35
120
155
273
465
1585
316
423.15

1000
709

291
365

1455
1566
873

1 0441.5

1° 40'

1502
365

7510
9012
4506

548.230

9 8

45

blue

1° 39' Pt
99
102
1410

58' ?

blue

~~2° 59'~~

blue

2° 59' 1745 DV
129
179
182

blue

5° 22'
323
325

~~10~~

3° 8'

3° 1'

3° 12

40 12

60
240
.1
252
5

16) 65 (.4
68

5.4
7.5
12.9

Pony

535 | 2 7283
11.75 | 1.0700
10.4 | 1.0170
~~0.9731~~

~~4.7777~~

~~59.100~~ ft. lbs.
4.8183

#

65.500

700 Revs. machine

480
480
5280
129

3.7226
1.1106
4.8332

68.100.

$\frac{700}{1100} \cdot 40$

$\frac{5600}{11\,00}$ 5.1

6 1/2 lbs

497 revo

6 lbs

11° 35' Dynamometer

200 on high resistance

495

6 1/4

200 H.R

11° 45'

Wt Cutch 563 grms 14 grms

Co 3 530 grms 7

Accepting his figures 5

Engineering May 9, 1879 Dr Hopkinson's tests If 1.079 Volts = 2M.7 1 Dynamo

1.079	.03302
1.125	.05115
	$\bar{1}.98187$
then	2
.919	$\bar{1}.96374$
91.9%	1.96374

Assume total resistance of machine as 0.683 ohms as this is the normal temperature after running some time as 0.14 ohm is the normal temperature of the Edison machine

log 0.683 = $\bar{1}.83442$
antilog — 10.16558

Ex 4 4.07 Ohms Total
3.387 — outside
1.149 Eng.ᵍ Total work in current.

1.179 Eng.ᵍ Dynamometer

$$\frac{1.149 \times .919 \times \frac{3.387}{4.07} \text{ per cent}}{1.179}$$

1.149	.06032
.919	$\bar{1}.96374$
comp 1.179	9.92849
.876% Total	$\bar{1}.95255$
3.387	.52982
comp 4.07	9.39041
74.6% outside	$\bar{1}.87278$
H.P. 1.68	.22531
1.25	0.09809

407
.683
3.387

Ex 5 3.88 Ohms

1.285 Eng^10 in current
1.263 Eng^10 in belt
which is impossible

3.88
.683
3.197 Ohms external

	1.285	0.10890
	91.9	1.96374
Comp	1.263	9.89860
	93.1%	1.96924
	3.197	0.50474
comp	3.88	9.41117
		1.88515

76.7%

Ex 6 3.205 Ohms Total

0.683
2.512

Eng^10 1.972 Total work in current
" 2.106 " " " belt
2.81 H.P

	1.972	.29491
	91.9	1.96374
comp	2.106	9.67654
	86.1%	1.93519
	2.512	0.40002
comp	3.205	9.49417
		1.82938

67.5%

Ex 7

3.025 Ohms Total
0.683
2.342 Ohms outside

2.174 Eng^o Total work in current
2.392 " " " " belt
3.19 H.P.

2.174	0.33726
91.9	1.96374
comp 2.392	9.62124
83.6%	1.92224
2.342	0.36959
comp 3.025	9.51927
64.7%	1.81110

Ex 8

2.62 Ohms total
.683
1.937 Ohms outside

2.718 Eng^o total work in current
2.780 " " " " belt
3.71 H.P.

2.718	.43425
91.9	1.96374
comp 2.780	9.55595
89.9%	1.95394
1.937	0.28713
comp 2.62	9.58170
66.5%	1.82277

Ex 9 2.43 Ohms total
.683
1.747

2.894 Eng^o work in current
3.370 " — — belt
4.49 H.P.

	2.894	0.46150
	91.9	1.96374
comp	3.370	9.47237
	79%	1.89761
	1.747	0.24229
comp	2.43	9.61439
	56.8%	1.75429
	4.49	6522
		.4064
	2.55	

Ex 10 2.28 Ohms Total
.683
1.597 — outside

3.138 Eng^o Total work in current
3.538 " — — — belt
4.72 H.P.

	3.138	0.49665
	91.9	1.96374
comp	3.538	9.45124
	81.6%	1.91163
	1.597	0.20330
comp	2.28	9.64207
	57.1%	1.75700
	4.72	.6739
		.4309
	2.7	

Ex. 11 2.08 Ohms total
0.683
1.397 Ohms outside

3.671 Eng^o in current
3.900 Eng^o in belt
5.28 H.P

3.671	0.56478
91.9	1.96374
comp 3.96	9.40230
	1.93082
85.3%	0.14520
1.397	9.68194
comp 2.08	
	1.75.796
57.2% outside	.7226
	.4805

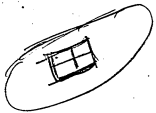
3.02 H.P. outside

Ex. 12 1.345
.683
.662

5.51 Eng^o total work in current
5.777 — — — — belt
7.7 H.P.

5.51	0.74115
comp 5.777	9.23830
95.4	9.97945
91.9	1.96374
87.7	1.94319
.662	$\bar{1}.82086$
comp 1.345	9.87128
	1.63533
43.1%	0.86649
	$\bar{1}.52182$

3.32 H.P. delivered outside



2.894
3.138
3.671
5.510

4) 15.213
3.803 log 10

3.370
3.538
3.966
5.777

4) 16.645
4.161 log 10

3.803 .58013
4.161 .61920
1.96093 91.5%
58013 1.96374
96374 .92467
54387
61920
.92467
3.45 84%

4.49
4.72
5.28
7.70

4) 22.19
5.55 H.P. in belt

839) 907 (10
839
680

907
839
68) 907 (1.33
68
227
204
23

2.55
2.7
3.02
3.32

4) 11.59
2.89 H.P. outside

2.89 .4609
5.55 .7443
.7166
52%

137 mm

h = height Hg. in mm to compress

h' = distance from top tube

v = volume bulb & tube

v''' = ~~[illegible]~~ tube

V'' = ~~[illegible]~~ 1 mm tube

Bulb

```
  1488
  1525
  1507
  1132
 -----
  5652
  2088
 -----
  3564
   522
     4
 -----
  2088
```


3564 grammes in bulb

```
                 3564
                 5422
32.7814 V = 35694 22
27.3585
-------
 5.4229

137)5422.9 (39.57 = V''
    411
    ---
     1312
     1233
     ----
       799
       685
       ---
       1140
```

$760 \quad \frac{V}{V''} \quad \frac{1}{R^2}$

```
39.57) 3569422 00 ( 90205 = V/V'
       35613
        8122
        7914
         2080.0
```

```
   90205
     760
 54123 00
 63 14 35
 68555800 = 760 V/V''
```

Formulae

H = height of Hg. in tube

h = distance from top tube

l = length tube

V = Weight Hg in tube and bulb

v = " " " tube

$\frac{V}{l}$ = " " " 1 mm

p = original pressure

$\frac{V}{v}\,\frac{760}{H}$ = millionths = ϕ to entrance tube

$\frac{V}{l}\,\frac{760}{H}$ = millionths to 1 mm = $\frac{lV}{v}\,\frac{760}{H} = p$

$\frac{lV}{vh}\,\frac{760}{H}$ = millionths at h mm from top of tube

$h = H$

$\frac{lV}{v}\,\frac{760}{H^2}$

$(V+v)\,p = (p+H)\,v$

Franz gauge

l = 131 mm

V = 422478 mg.

v = 712 mg.

$$712\overline{)422478}\ (593.3 = \frac{V}{v}$$

3560
6647
6408
2398
2136
2620

593.3
760
355980
41531
450908.0
131
450908
135271.4
450908
590689.46

$$760\,\frac{V}{v} = 450908.0$$

$$\frac{lV}{v}\,760 = 590689.46$$

Gauge up stairs

$l = 137$ mm

$V = 3569422$ mg.

$v = 5423$ mg.

```
5423)3569422(658 = V/v
     32538
      31562
      27115
       44470
       43384
          658
          760
        40480
       4606
760 V/v  501080
          137
      3507560
      15,0324
      50,1,08
      68,647,600
```


Small gauge 59.000,000
large " 68.600,000

Small gauge .43
large .32

Capillarity in small gauge
10 mm
18 mm from the end
in the small gauge would
represent a millionth

Lamp holds 4 lbs 10 oz

$4.500
5
$22.500
.03
675.00

250 H.P.

.171
136
35000
35000

6425
4825
1600
35.00
5100
25.00
7.600

22500
.02
45000

6 | 1250
416
1666

| 86000
28666
114666
50000
$ 164666

| 3835
1278
5113
1000
6113

Boilers & Chimney		21000
Engines		22.500
Foundation. —		
Structure —		7.000
Shafts & —		
Belts —		
Wood flooring & —		
Water heater & pumps		7.000
Iron floor & Boiler supports		6.000
Faradic Machines		22.500
Conductors		50.000
		$ 136.000
		50
		86000
Plant $171.400		
50		
85.700		
Depreciation		
Boilers & Chimney	10%	2.100
Engines	3%	675
Structure	2%	140
Water heater & pumps	5%	350
Boiler floor	2%	120
Faradic Machines	2%	450
Conductors	2%	1000
		4835

6 per H.P.

1250 H.P.
6

Labor. $33 per day

Coal $29.30 per day

Rent &c $7500 per year

Investment $164666

Depreciation $6113

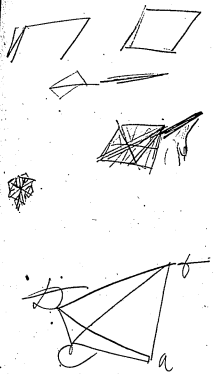
Sophia

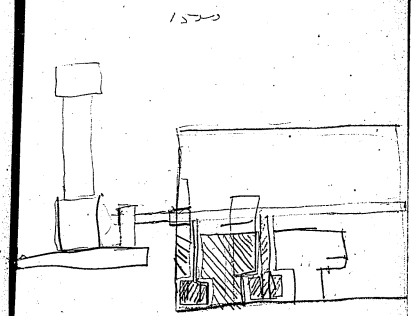
Sophia Potter

Miss P.

Miss Sophia Latom
Hotel Brunswick
N.Y.

Miss
C C M





$\frac{12}{13}$ $\frac{12}{13}$

$$W = C\mathcal{E} = C(\mathcal{E}' + \mathcal{E}'')$$

$$\mathcal{E}' = CR$$

$\mathcal{E}''$ = Contrary E.M.F. Motor

$$W' = C^2R = \mathcal{E}'C = \frac{\mathcal{E}'^2}{R}$$

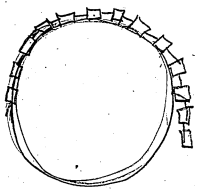
$$W'' = W - W' = C\mathcal{E} - \frac{\mathcal{E}'^2}{R}$$

10 H.P.

2.5 H.P.

3/4 47%

$$\begin{array}{r} 83 \\ 83 \\ \hline 249 \end{array}$$



$$\mathcal{E}' = C R$$

r = resistance machine

Condition Work outside $= W_0$

$W_0 = 12 C^2 r$

$$W_0 = 12 C^2 r$$

$$W_0 = C(\mathcal{E}' + \mathcal{E}'') - C^2 r$$

$$= C\mathcal{E}'' + C^2(R - r) = 12 C^2 r$$

$$C = \frac{\mathcal{E} - \mathcal{E}''}{R}$$

$$\mathcal{E}'' + C(R - r) = 12 C r$$

$$\mathcal{E}'' = 13 C r - C R$$

$$= C(13 r - R)$$

$13r = R$ $\quad \mathcal{E}'' = 0$

$5r = R \qquad r = \frac{R}{5}$

$$\mathcal{E}'' = C\left(\frac{13R}{5} - R\right)$$

$$= \frac{8CR}{5} \qquad CR = \mathcal{E}'$$

$$\mathcal{E}'' = \frac{8}{5}\mathcal{E}' \qquad \mathcal{E}' + \mathcal{E}'' = \mathcal{E}$$

$$\mathcal{E}' = \mathcal{E} - \mathcal{E}''$$

$$\mathcal{E}'' = \frac{8}{5}\mathcal{E} - \frac{8}{5}\mathcal{E}''$$

$$\mathcal{E}'' + \frac{8}{5}\mathcal{E}'' = \frac{8}{5}\mathcal{E}$$

$$13\mathcal{E}'' = 8\mathcal{E}$$

$$\mathcal{E}'' = \frac{8}{13}\mathcal{E}$$

W_0

Let it be assumed that $\frac{n}{m}$ of the total work can be recovered outside

Rise If there is no contrary E.M.F.

r = resistance Machine

R = Total outside resistance

$$R : r :: \frac{n}{m} : \frac{m-n}{m}$$

$$R = \frac{n}{(m-n)} r$$

If contrary E.M.F. $= \mathcal{E}''$

Current $= c$ $\quad \mathcal{E}' = \mathcal{E} - \mathcal{E}''$

W = work outside

w = work inside

$$W = \frac{n}{(m-n)} w$$

$$w = c^2 r$$

$$W = \frac{n}{m-n} c^2 r \quad (1)$$

$$w = c(\mathcal{E}'' + \mathcal{E}') - c^2 r$$

$$c\mathcal{E}' = c^2(R+r)$$

$$w = c\mathcal{E}'' + c^2(R+r) - c^2 r$$

$$= c\mathcal{E}'' + c^2 R \quad (2) \text{ of } (1)$$

$$\frac{n}{m-n} c^2 r = c\mathcal{E}'' + c^2 R$$

$$\frac{n}{m-n} c r = \mathcal{E}'' + cR$$

$$\cancel{\mathcal{E}'' r = \frac{n}{m-n} c(r}$$

$$\mathcal{E}'' = c\left(\frac{n}{m-n} r - R\right)$$

$$R = l r \quad R + r = (l+1) r$$

$$\mathcal{E}'' = c\left(\frac{n}{m-n} r - l r\right)$$

$$= c r \left(\frac{n}{m-n} - l\right) = c r \left(\frac{n - l(m-n)}{m-n}\right)$$

$$= c r \left(\frac{n - lm + ln}{m-n}\right)$$

$$= c r \left(\frac{n(1+l) - lm}{m-n}\right)$$

$$c = \frac{\mathcal{E}'}{R+r} = \frac{\mathcal{E}'}{l r + r} = \frac{\mathcal{E}'}{r(l+1)}$$

$$\mathcal{E}'' = c r \cdot \left(\frac{n(1+l) - lm}{m-n} \right)$$

$$= \frac{\mathcal{E}' r}{r(l+1)} \left(\frac{n(1+l) - lm}{m-n} \right)$$

$$= \frac{\mathcal{E}'}{l+1} \left(\frac{n(1+l) - lm}{m-n} \right)$$

$n = 12$

$m = 13$

$l = 5$

$$\mathcal{E}'' = \frac{\mathcal{E}'}{6} \left(\frac{12(6) - 5 \times 13}{13-12} \right)$$

$$= \frac{\mathcal{E}'}{6} (72 - 65)$$

$$= \frac{\mathcal{E}' 7}{6} = \frac{7}{6} \mathcal{E}$$

$l = 4$

$$\mathcal{E}'' = \frac{\mathcal{E}'}{5} \left(\frac{12 \times 5 - 4 \times 13}{13-12} \right)$$

$$= \frac{\mathcal{E}'}{5} \left(\frac{60 - 52}{1} \right)$$

$$= \frac{8}{5} \mathcal{E}'$$

Estimate ~~transmission~~

Three machines 600 Volts

To transmit

Two machines 400 Volts

receivers

200 Volts active

Resistance line 2 Ohms

m transmitters 1.68

1.12

4.80

$$\begin{array}{r} 1.68 \\ .56 \\ \hline 1.12 \end{array} \qquad \begin{array}{r} .56 \\ 2 \\ \hline 1.12 \end{array}$$

200	2.3010
200	2.3010
	1.6464
4.5	9.3188
	5.5672
369000	4.5185
	.0487

11.4 H.P.

$$\mathcal{E}'' = \frac{\mathcal{E}'}{l+1}\left(\frac{n}{m-n} - l\right) = g\,\mathcal{E}'$$

$$\mathcal{E}'' = \mathcal{E} - \mathcal{E}' \qquad \mathcal{E}' = \mathcal{E} - \mathcal{E}''$$

$$\mathcal{E}'' = g(\mathcal{E} - \mathcal{E}'')$$

$$\mathcal{E}'' + g\,\mathcal{E}'' = g\,\mathcal{E}$$

$$\mathcal{E}'' = \frac{g}{1+g}\,\mathcal{E}$$

$$= \frac{\frac{1}{l+1}\left(\frac{n}{m-n} - l\right)}{1 + \frac{1}{l+1}\left(\frac{n}{m-n} - l\right)}\,\mathcal{E}$$

$$= \frac{\frac{nl+n}{m-n} - l^2 - l}{l+1+1+\left(\frac{nl+n}{m-n} - l^2 - l\right)}$$

$$= \frac{nl+n-l^2m-lm+nl^2+ln}{\cancel{nl} - 2n + \cancel{nl} + n - l^2m - \cancel{lm} + \cancel{l^2n} + \cancel{ln}}$$

$$= 2nl + n - l^2m -$$

Let $n = 12$ $\qquad \frac{\mathcal{E}''}{\mathcal{E}'} = \frac{11}{2}$

$m = 13$

$l = 1$

$$\mathcal{E}'' = \frac{\mathcal{E}'}{2}(12-1) \qquad \mathcal{E}' = \frac{2}{13}\mathcal{E}$$

$$= \frac{11}{2}\mathcal{E}' = \frac{\frac{11}{2}}{\frac{11}{2}+1}\mathcal{E} = \frac{11}{13}\mathcal{E}$$

$l = 2$

$$\mathcal{E}'' = \frac{\mathcal{E}'}{3}(12-2) = \frac{10}{3}\mathcal{E}'$$

$$\mathcal{E}'' = \frac{10}{13}\mathcal{E} \qquad \mathcal{E}' = \frac{3}{13}\mathcal{E}$$

$\frac{\mathcal{E}''}{\mathcal{E}'} = \frac{9}{4}$

$l = 3$

$$\mathcal{E}'' = \frac{9}{13}\mathcal{E} \qquad \mathcal{E}' = \frac{4}{13}\mathcal{E}$$

$\frac{\mathcal{E}''}{\mathcal{E}'} = \frac{8}{5}$

$l = 4$

$$\mathcal{E}'' = \frac{8}{13}\mathcal{E} \qquad \mathcal{E}' = \frac{5}{13}\mathcal{E}$$

$\frac{\mathcal{E}''}{\mathcal{E}'} = \frac{7}{6}$

$l = 5$

$$\mathcal{E}'' = \frac{7}{13}\mathcal{E} \qquad \mathcal{E}' = \frac{6}{13}\mathcal{E}$$

$$W = C\mathcal{E}'' + C\mathcal{E}' - C^2 r$$

$$W = C\mathcal{E} - C^2 r$$

$$W = \frac{n}{m-n} C^2 r$$

$$C = \frac{\mathcal{E}'}{R+r}$$

$$W = \frac{n}{m-n}\left(\frac{\mathcal{E}'}{R+r}\right)^2 r$$

$$W = \frac{n}{m-n} C^2 r$$

$$W = C\mathcal{E} - C^2 r$$

$$W = C\mathcal{E}'' + C\mathcal{E}' - C^2 r$$

$$\mathcal{E}'' = 0$$

$$W = C\mathcal{E}' - C^2 r = C\mathcal{E}$$

$$= \frac{\mathcal{E}^2}{R+r}$$

$$\mathcal{E}' = \mathcal{E} - \mathcal{E}''$$

$\mathcal{E}$ is constant

$\mathcal{E}''$ ~~[illegible]~~ $f(l)$

$\mathcal{E}'$ $f(l)$

m & n = constants

$$C = \frac{\mathcal{E} - \mathcal{E}''}{R+r}$$

$$\mathcal{E}'' = \frac{g}{1+g}\mathcal{E}$$

$$C = \frac{\mathcal{E} - \frac{g}{1+g}\mathcal{E}}{R+r}$$

$$= \frac{\mathcal{E}\left(\frac{1+g-g}{1+g}\right)}{R+r}$$

$$= \frac{\frac{1}{1+g}\mathcal{E}}{R+r}$$

$$W = \varepsilon - \varepsilon^2 r$$

$$= \frac{\frac{1}{1+g}\varepsilon^2}{R+r} - \left(\frac{\frac{1}{1+g}}{R+r}\varepsilon\right)^2 r$$

$$= \frac{\varepsilon^2}{R+r}\left(\frac{1}{1+g} - \frac{\left(\frac{1}{1+g}\right)^2}{R+r} r\right)$$

$$R = \ell r$$

$$= \frac{\varepsilon^2}{R+r}\left(\frac{1}{1+g} - \frac{\left(\frac{1}{1+g}\right)^2}{(\ell+1)r} r\right)$$

$$= \frac{\varepsilon^2}{R+r}\left(\frac{1}{1+g} - \frac{\left(\frac{1}{1+g}\right)^2}{\ell+1}\right)$$

$$= \frac{\varepsilon^2}{R+r}\left(\frac{1}{1+g}\left(1 - \frac{\frac{1}{1+g}}{\ell+1}\right)\right)$$

$$= \frac{\varepsilon^2}{R+r}\left(\frac{1}{1+g}\left(\frac{\frac{1+g-1}{1+g}}{\ell+1}\right)\right)$$

$$= \frac{\varepsilon^2}{R+r}\left(\frac{1}{1+g}\left(\frac{\frac{g}{1+g}}{\ell+1}\right)\right)$$

$$= \frac{\varepsilon^2}{R+r}\left(\frac{\frac{g}{(1+g)^2(\ell+1)}}{}\right)$$

$$\varepsilon'' = 0$$

$$\frac{m}{m-n} = \ell$$

$$n = 12$$

$$m = 13$$

$$\ell = 1$$

$$g = \left(\frac{n}{m-n}\right)\ell = 12 - 1 = 11$$

$$= \frac{\varepsilon^2}{R+r}\left(\frac{11}{(1+11)^2(1+1)}\right)$$

$$= (\quad)\ \frac{11}{144 \times 2} = (\quad)\ \frac{11}{288}$$

$$\varepsilon'' = \frac{11}{13}\varepsilon \qquad \varepsilon' = \frac{2}{13}\varepsilon$$

$$\frac{\varepsilon''}{\varepsilon'} = \frac{11}{2}$$

$$\frac{44}{338} = \frac{8}{338} = \frac{52}{338} = \frac{4}{26} = \frac{2}{13}$$

$$W = \frac{\varepsilon^2}{R+r}\left(\frac{1}{1+g} - \frac{\left(\frac{1}{1+g}\right)^2}{l+1}\right)$$

$$= ()\left(\frac{1}{1+g}\left(\frac{l+1-\frac{1}{1+g}}{l+1}\right)\right)$$

$$= ()\left(\frac{1}{1+g}\left(\frac{l+\frac{g}{1+g}}{l+1}\right)\right)$$

$g = 11 \quad l = 1$

$$= ()\frac{1}{12}\left(\frac{1+\frac{11}{12}}{2}\right)$$

$$= ()\frac{1}{12}\left(\frac{\frac{23}{12}}{2}\right)$$

$$= ()\frac{23}{288}$$

$$\begin{array}{r} 13 \\ 48 \\ 16 \\ \hline 208 \end{array}$$

$$\frac{2}{13}$$

ε'' $\quad \frac{4}{169}$

$$\frac{23}{288}$$

100

4430.00

33) 886 (26 H.P.

66

226

200 Volts 100 H.P

300

225

10 lbs to ton

52,800 600

$n = 3 \qquad l = 1$

$m = 4$

$q = \left(\frac{n}{m-n} - l\right) = 3 - 1 = 2$

$q = 2$

$\varepsilon'' = \frac{q}{1+q}\,\varepsilon = \frac{2}{3}\,\varepsilon$

$\varepsilon' = \frac{1}{3}\,\varepsilon \qquad \frac{\varepsilon''}{\varepsilon'} = 2$

$W = l\left(\frac{1}{1+q}\,\frac{l + \frac{q}{1+q}}{l+1}\right)$

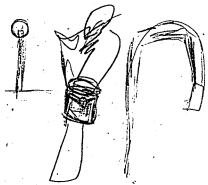
$= ()\left(\frac{1}{3}\,\frac{1 + \frac{2}{3}}{2}\right)$

$= ()\left(\frac{1}{3} \times \frac{5}{6}\right) = ()\,\frac{5}{18}$

$\frac{1}{9}\,\varepsilon$

$\frac{1}{9} + \frac{2}{9} = \frac{3}{9} = \frac{1}{3}$

$\frac{1}{3} - \frac{1}{4}\,\frac{1}{3} = \frac{4}{12} - \frac{1}{12} = \frac{3}{12} = \frac{1}{4}$



$$C = \frac{\mathcal{E}'}{R+r}$$

$$\mathcal{E}' = C\,R + r$$

$$\mathcal{E} = \mathcal{E}' + \mathcal{E}''$$

$$= C(R+r) + \mathcal{E}''$$

Let r = resistance machine

R = outside resistance

$\mathcal{E}$ = E.M.F transmitter constant

$\mathcal{E}''$ = — motor variable

$\mathcal{E}'$ = $\mathcal{E} - \mathcal{E}''$ = E.M.F active

W = work outside

w = work inside.

C = Current

$n = \frac{W}{w}$ constant

$l = \frac{R}{r}$ variable

$$\mathcal{E} = C(R+r) + \mathcal{E}''$$

$$W = C(\mathcal{E}' + \mathcal{E}'') - C^2 r$$

$$W = nw = nC^2 r$$

$$nC^2 r = C(\mathcal{E}' + \mathcal{E}'') - C^2 r$$

$$nCr = (\mathcal{E}' + \mathcal{E}'') - Cr$$

$$C(nr + r) = \mathcal{E}' + \mathcal{E}''$$

$$C =$$

$$\mathcal{E} = \mathcal{E}' + \mathcal{E}''$$

$$c(\mathcal{E}' + \mathcal{E}'') = W + w$$

$$c = \frac{\mathcal{E}'}{R + r}$$

$$w = c^2 r$$

$$c(\mathcal{E}' + \mathcal{E}'') = W + c^2 r$$

$$c(\mathcal{E}' + \mathcal{E}'') - c^2 r = W$$

$$\frac{\mathcal{E}'}{R + r}(\mathcal{E}' + \mathcal{E}'') - \left(\frac{\mathcal{E}'}{R + r}\right)^2 r = W$$

$$l = \frac{R}{r} \qquad R = lr$$

$$\frac{\mathcal{E}'}{(l+1)r}(\mathcal{E}' + \mathcal{E}'') - \left(\frac{\mathcal{E}'}{(l+1)r}\right)^2 \frac{1}{r} = W$$

$$W = nc^2 r$$

$$= \left(\frac{n\mathcal{E}'}{R + r}\right)^2 r$$

$$= \frac{n\mathcal{E}'^2}{(1+l)^2 r}$$

$$= \frac{\mathcal{E}'}{(1+l)r}(\mathcal{E}' + \mathcal{E}'') - \left(\frac{\mathcal{E}'}{1+l}\right)^2 \frac{1}{r}$$

$$n\mathcal{E}'^2 = (1+l)\mathcal{E}'(\mathcal{E}' + \mathcal{E}'') - \mathcal{E}'^2$$

$$n\mathcal{E}' = (1+l)(\mathcal{E}' + \mathcal{E}'') - \mathcal{E}'$$

$$(1+n)\mathcal{E}' = (1+l)(\mathcal{E}' + \mathcal{E}'')$$

$$(1+n-1-l)\mathcal{E}' = (1+l)\mathcal{E}''$$

$$\mathcal{E}' = \frac{1+l}{n-l}\mathcal{E}'' = \mathcal{E}'$$

$$n = 12$$

$$l = 1$$

$$\mathcal{E}' = \mathcal{E} - \mathcal{E}''$$

$$\mathcal{E}' = \frac{2}{11}\mathcal{E}'' \qquad \frac{2}{11}\mathcal{E}'' = \mathcal{E} - \mathcal{E}''$$

$$\mathcal{E}'' = \frac{11}{13}\mathcal{E} \qquad \frac{13}{11}\mathcal{E}'' = \mathcal{E}$$

$$\mathcal{E}' = \frac{1+l}{n} \qquad \mathcal{E}' = \frac{2}{13}\mathcal{E}$$

$$\mathcal{E}' = \frac{1+l}{n-l}\,\mathcal{E}'' = h\,l$$

$$\mathcal{E}'' = \mathcal{E} - \mathcal{E}'$$

$$\mathcal{E}' = h\,\mathcal{E} - h\,\mathcal{E}'$$

$$\mathcal{E}' + h\,\mathcal{E}' = h\,\mathcal{E}$$

$$\mathcal{E}' = \frac{h\,\mathcal{E}}{1+h}$$

$$\frac{\frac{1+l}{n-l}}{1+\frac{1+l}{n-l}} = \frac{\frac{1+l}{n-l}}{\frac{n-l+1+l}{n-l}}$$

$$= \frac{1+l}{n+1} = \frac{1+l}{1+n}$$

$$\mathcal{E}' = \frac{1+l}{1+n}\,\mathcal{E} = g\,\mathcal{E}$$

$$n = 12 \qquad l = 1$$

$$\mathcal{E}' = \frac{2}{13}$$

$$\mathcal{E}'' =$$

$$\mathcal{E}'' = \left(1 - \frac{1+l}{1+n}\right)\mathcal{E}$$

$$= \left(\frac{1+n-1-l}{1+n}\right)\mathcal{E}$$

$$= \frac{n-l}{1+n}\,\mathcal{E}$$

$$\mathcal{E}'' = \frac{11}{13}$$

$$W = n\,w = n\,c^2 r$$

$$W = c\,\mathcal{E}' - n\,c^2 r$$

$$c = \frac{\mathcal{E}'}{R+r} = \frac{\frac{1+l}{1+n}\,\mathcal{E}}{R+r}$$

$$\mathcal{E}' \qquad R+r = l+r = (1+l)r$$

$$c = \frac{1}{(1+n)r}\,\mathcal{E}$$

$$W = \frac{1}{(1+n)r}\,\mathcal{E}^2 - n\left(\frac{1}{(1+n)r}\,\mathcal{E}\right)^2 r$$

$$= \frac{\mathcal{E}^2}{(1+n)r}\left(1 - \frac{n}{1+n}\right)$$

$$= \frac{\mathcal{E}^2}{(1+n)r}\left(\frac{1}{1+n}\right)$$

$$= \frac{\mathcal{E}^2}{r}\left(\frac{1}{1+n}\right)^2$$

$$\underline{\mathcal{E}^2} \qquad \mathcal{E}'' = 0$$

$$n = 2$$

$$W = n\,\mathcal{E}^2 r$$

$$\frac{\mathcal{E}^2}{R+r}$$

$$\underline{\mathcal{E}^2}$$

$$\frac{\mathcal{E}^2}{R}$$

$$c = \frac{g\,\mathcal{E}}{R+r}$$

$$W = \frac{g\,\mathcal{E}^2}{R+r} - n\,\frac{g^2\mathcal{E}^2}{(R+r)^2}\,r$$

$$= \frac{g\,\mathcal{E}^2}{R+r}\left(1 - \frac{n\,g\,r}{(R+r)^2}\right)$$

$$= \frac{g\,\mathcal{E}^2}{R+r}\left(1 - \frac{n\,g\,r}{(R+r)^2}\right)$$

$$= \frac{g\,\mathcal{E}^2}{R+r}\left(1 - \frac{n\,g\,R}{(1+\varepsilon)\,r^2}\right)$$

$$= \frac{g\,\mathcal{E}^2}{R+r}\left(1 - \frac{n\,g}{(1+\varepsilon)\,r}\right)$$

$$\boxed{g = 1}$$

$$c = \frac{g\,\mathcal{E}}{R+r} = \frac{g}{\sigma}\,\frac{\mathcal{E}}{R+r}$$

$$c = \frac{g\,\mathcal{E}}{R+r}$$

$$W = nw = nc^2 r$$

$$\left(\frac{\varepsilon^2}{R+r}\right) \quad \text{dependant on } e$$

$$g = \frac{1+e}{1+n}$$

$$c = \frac{\varepsilon'}{R+r} = \frac{g\varepsilon}{R+r}$$

$$W = n\frac{g^2\varepsilon^2}{(R+r)^2}\, r$$

$$= \frac{\varepsilon^2}{R+r}\,\frac{ng^2}{R+r}\, r$$

$$= \frac{\varepsilon^2}{R+r}\,\frac{n\left(\frac{1+e}{1+n}\right)^2}{(1+e)\cancel{r}}\,\cancel{r}$$

$$W = \frac{\varepsilon^2}{R+r}\, n\,\frac{1+e}{(1+n)^2}$$

$n = 1$

$$W = \frac{\varepsilon^2}{R+r}\,\frac{n}{1+n} \quad \text{O. K}$$

$$n = 12$$

$$e = 1$$

$$W = \frac{\varepsilon^2}{R+r}\, 12\, \frac{2}{13^2}$$

$$= \frac{\varepsilon^2}{R+r}\,\frac{24}{169}$$

$$\left(\frac{2}{13}\right)^2 = \frac{4}{169}$$

$$\frac{11}{2} \times \frac{4}{169} = \frac{22}{169} \quad \frac{2}{169} = \frac{24}{169}$$

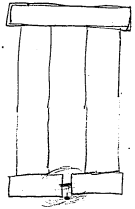
$$W = (\;)\,\frac{n(1+e)}{(1+n)^2}$$

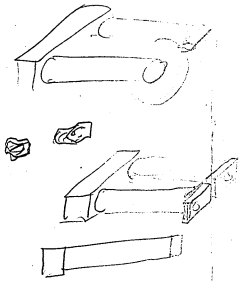
$$W = (\;)\,\frac{n(1+e)}{(1+n)^2}$$

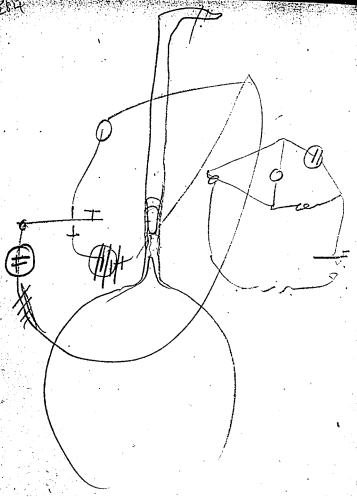
The = The Number

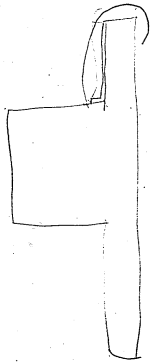
Friday Friday

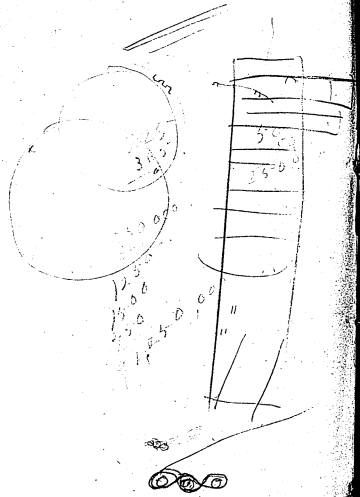
Friday Fran





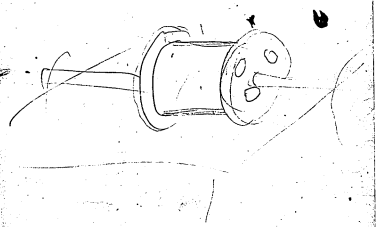






Do you want
any help is paid
on the box
on Express train

b/2, Kreiner



Menlo Park Notebook #60 [N-80-10-25]

This notebook covers the period October-November 1880. It contains drawings by Edison for patent applications and caveats, along with drafts by Edison of two caveats. The subjects include carbon lamps, sockets, meters, and dynamos. The name of Charles Batchelor appears frequently as a witness. The label on the front cover is marked "Sketches for Patents" and "Edison." The book contains 64 numbered pages. The left-hand pages are unnumbered.

Blank pages not filmed: 64.

No 60

PATENTON'S
FORTY-NINTH AVENUE, N. Y.
Sign of 100 Heads
172 100 Aves.

LIBRARY OF THE

BOARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

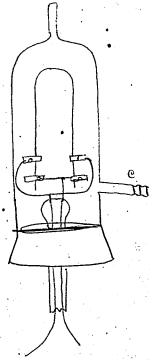
Brown Robinson
[illegible] N.Y.

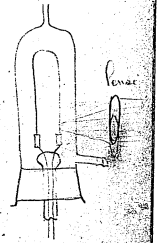
[illegible], 189..

Patent Oct 25 1880-

T.A.E.
Chas Batchelor

Chlorine first
then a volatile paraffin.





using a Rheostat, or the
arc

Jar may be put on at lower
End + paraffine put on it --

[ITEM FOUND IN BOOK]

BS 68 p. 175 – Monash

23 – 81.77, Feb. 22, 1979

22 – 27 Mar. 29, 79 (d.)

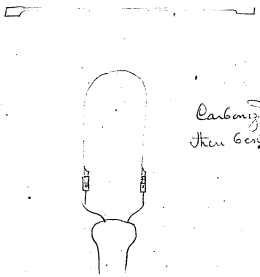
45 – 54 – pub. Jan. 80

112 – 37, 281 Sept. 21, 80

186 – 13 — 1/4/81

60 – 1 Oct. 6, 80

Caveat Oct 25 1880
T A E
Chas Batchelor



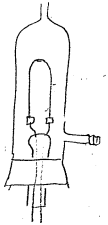
Carbonized Straights
then bent

Caveat

Oct 25 1880

T.A.E.

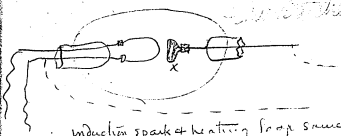
Chas. Batchelor



platinum - nickel cobalt
or other infusible metal
brought to incandescence
in a carbon vapor
+ carbon deposited.
this then charged off
or driven by torrents
by exciting the metal -

Concept -

Oct. 25, 80

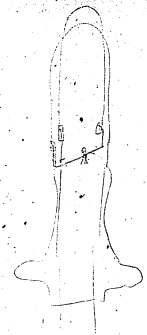


· induction spark & heating loop source
· time - · vapor of volatile gasoline in
· tube or · Carbon ~~X~~ soaked in tar -
Electrical Carrying Coats
Carbon

Carbonize under pressure -

Oct 26 1880

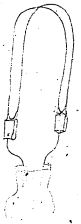
Patent



Oct 26 1880

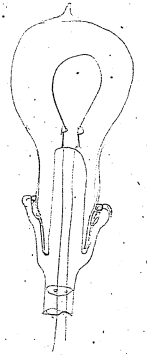
TAE

Glue Bottle



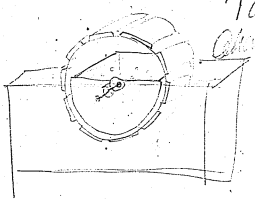
patent

Oct 29 1880
TAS



Patent

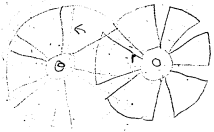
Oct 29 1880,
TOE
Chi[illegible]

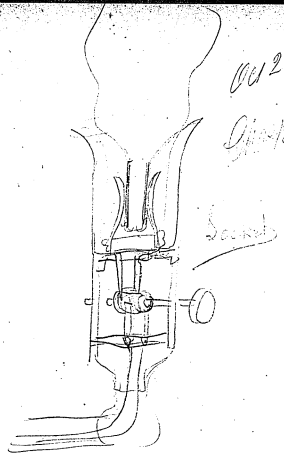


C

Oct 30 1880
TAE

Edison's Pot Detector
Meter

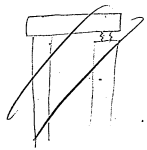


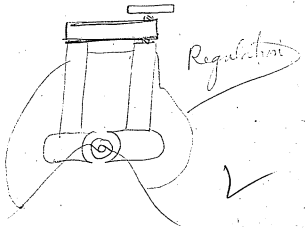


11
Oct 25 1881
Sin-Bottom

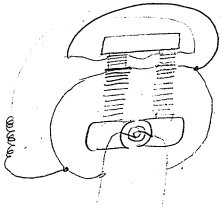
Oct 30 1880

Tail





Oct 30 1880 T.A.E



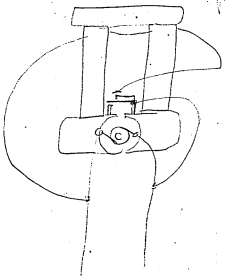
Regulation

Oct 30 1880

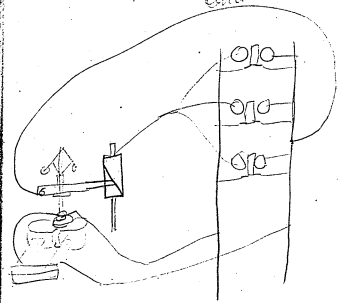
- T.A.E

Schwe Batterie

Magnetfeld



Oct 30. 1850 Tues
Cellar/Distillation

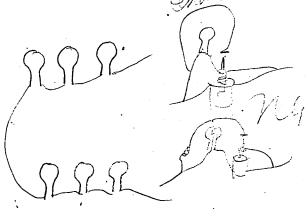


Regulation

Oct 30 1880 16

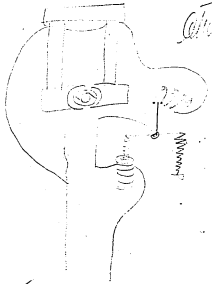
TCE

Grampstitches



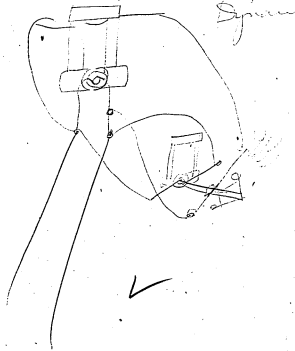
N4

Oct 31 1880



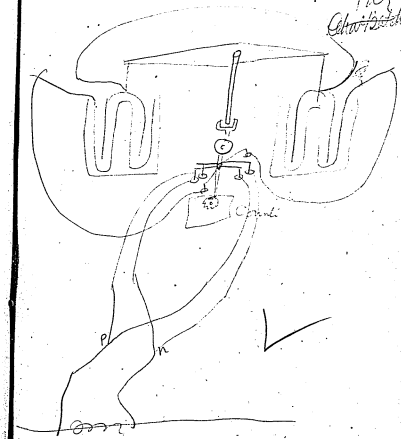
Oct 31 1880 T.C.E

Transmitting Chas. F. Brattiles Dynamo

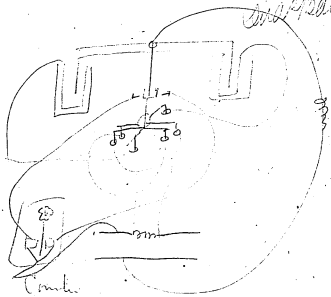


Oct 31 1880

TAS



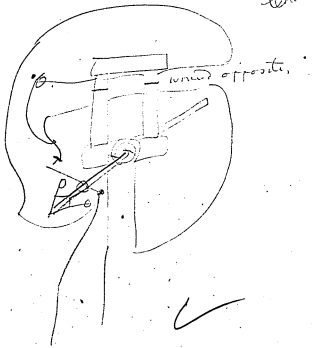
Oct 31 1880



Oct 31 1880

Tar

Motor

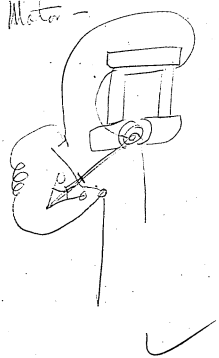


Oct. 31 1880

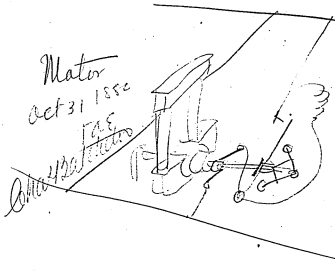
Motor –

Tail

Gear-Ratchet

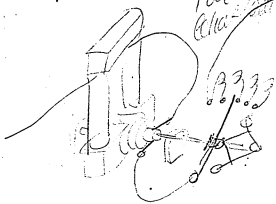


Motor
Oct 31 1956



Motor Oct 31 1880

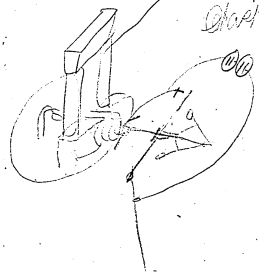
TAE



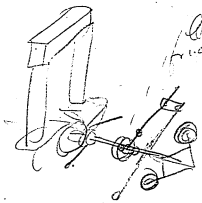
L

Motor Oct 31 1880

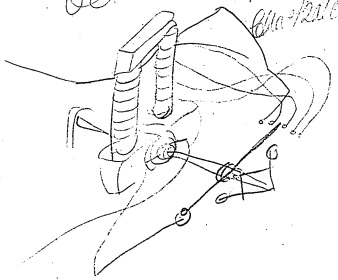
Tae



Mater Oct 31 1886



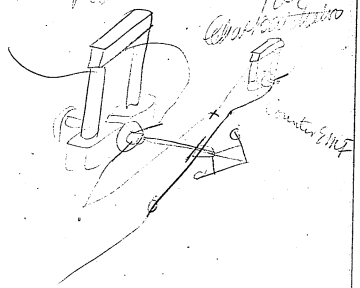
Motor
Oct 31 1880 TAE



Cutting wire Coil
magnetized by [illegible]

Oct 31 1880

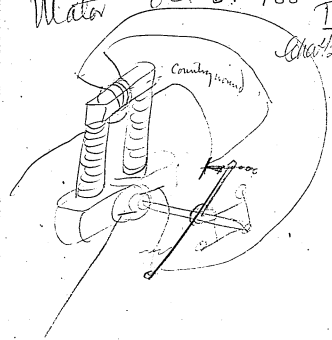
Motion

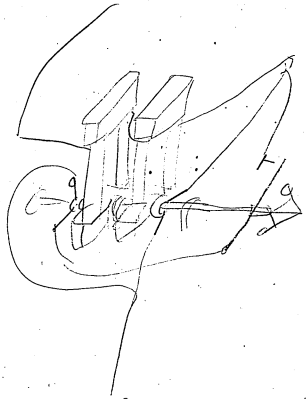


Motor Oct 31 1880 29

TOE

Chas Babbitt





Motor - 9000 throws one in 2 inches

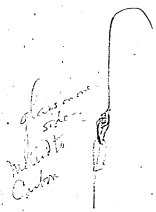
in — Oct 31 1860

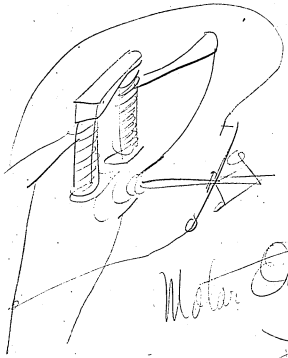
T a E

~~Charlottesville~~

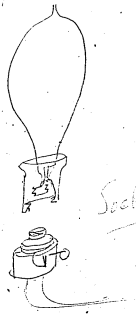
Oct 31 1880

T. P. Thurin
Chas Batchelor





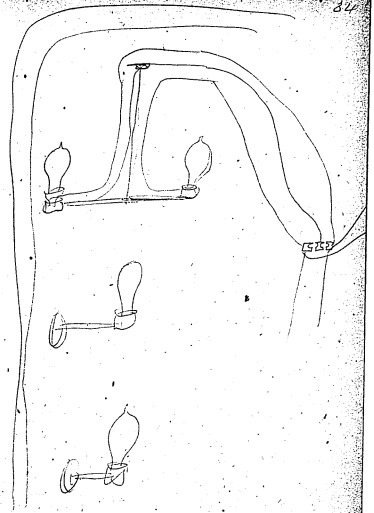
Motor Oct 31
1880
Tues
Ultra-Potentiator



Oct 31 1890

Fig

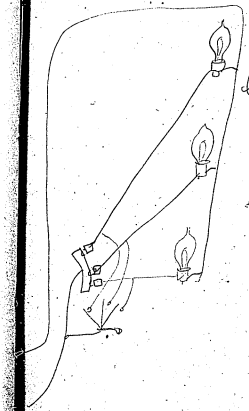
Sketch Ultra-Violet Detector



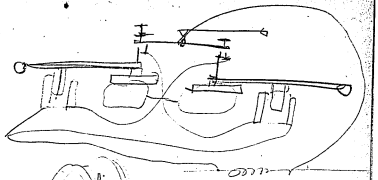
Oct 31 1880

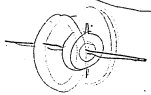
TAE

Wax patchett

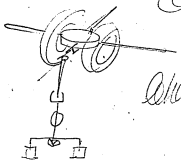


Lighting Each one
at switch, all
at once,



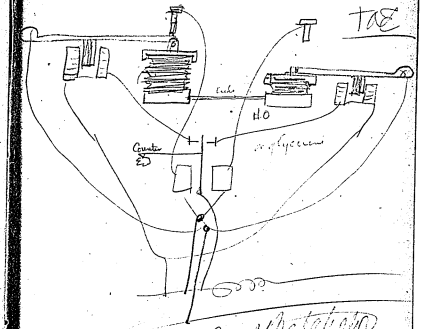


Milan
Oct 31 1880
TNE
Chairman



Mutu Oct 31 1880

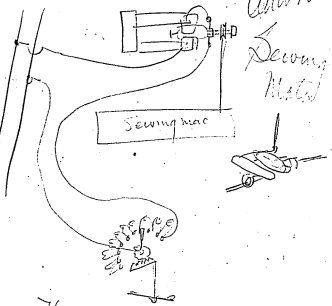
TAE



Omar Hatchett

Oct 21 1880

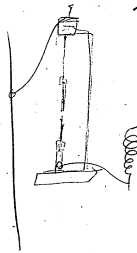
The Author's Patent Sewing Machine Motor



The pedal Regulating Spring by Resistance or it may Regulate the Governor

Oct 31 1880 TAE

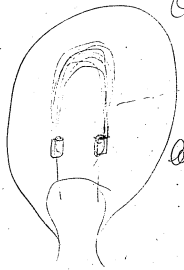
Electrotelephone



Rep in arc light

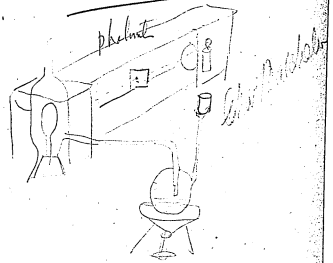
to prevent disturbing other lights =

Oct 31 1880
TAE



Very fine tubes
Chalmers
Chas Hutchison

Oct 31 1880 TAE



Oct 31 1880 — TAE

for isolated Engines and Dynamos such as used for boats & I propose to carry out the idea of Putting the field magnet in Multiple arc, and so arrange the wire of lamps that when all the lamps are on the field magnet will still be nearly saturated (1c)

The current will still be sufficient to nearly saturate the Magnetto also arrange it that should the speed increase ~~but~~ to such an extent by accident as to double the light in the lamps a magnet will open the circuit of lamps & feeding

Oct 31 1880 48

or perhaps I will use
a governor on the dynamo
itself which when the
field is deviated by any
great variation of speed
is attained by acc. ent.
the governor will move a
lever & open the field
more or not

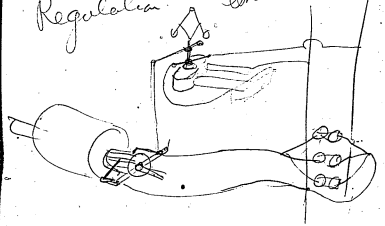
Oct 31 1880 TAE

I propose to make a pulping machine that will pulp paper fibre to extreme fineness & make paper from it & submitting the paper to hydraulic pressure & a flame cut Carbons from it & Coat them with Carborundum with a layer of the Carbon — Chlorotheum

I also propose to Comb the finest flax or hemp fibre longitudinally & moistened with a gummy substance which will be carborundum & press sheets of this by pressure & afterwards cut as with Bamboo —

Nov 2 1880 Tag

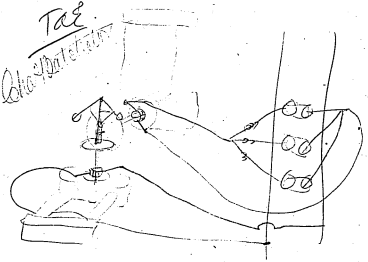
Regulation Observation



Nov 2 1880

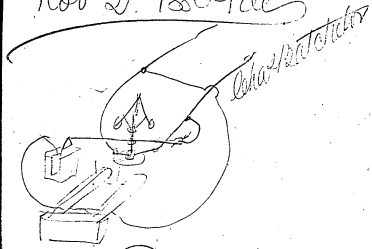
Tae

Chesterfield



Regulation

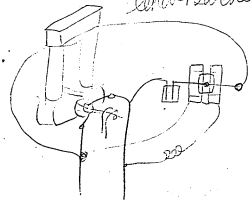
Nov 2. 1880 TCE



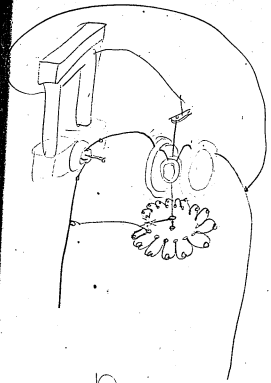
Regulator

Nov 2 1880 TAE

Lehael Batchelor



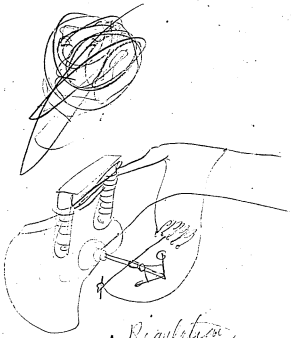
Regulator



Regulation Nov 2 1880

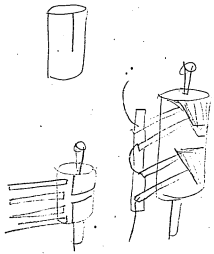
TNE

~~Transparatchers~~



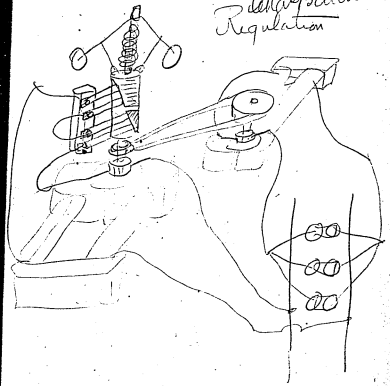
Regulation

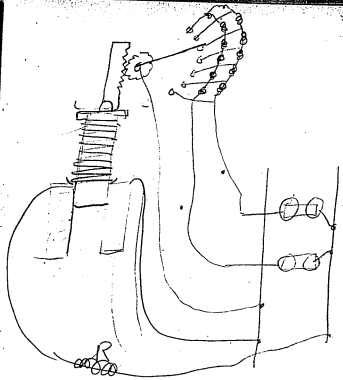
Nov 2. 1880 Tues
~~Chas~~ Butchelor



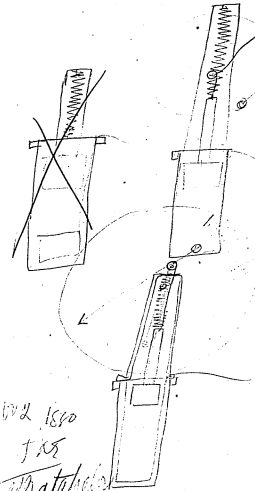
Nov. z 1880 TAE

Regulation



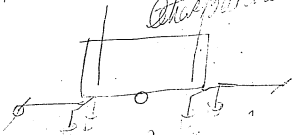


Regulation
Nov 2 1850
TAE
Chas Palatin

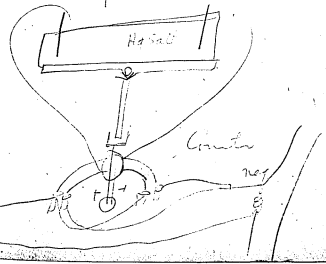

Nov 2 1890
J. N.
Patched

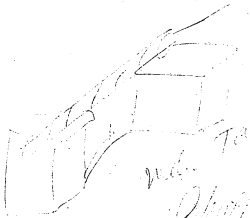
1600 2 1850 7C

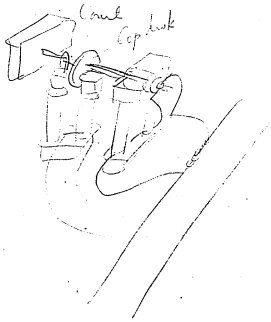
Other particulars



Kg-Meter







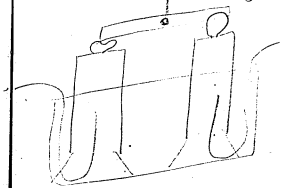
Motor No. 2 [illegible]

TOK

[illegible]

Nov 2. 1880 Tas

Glass Bottles

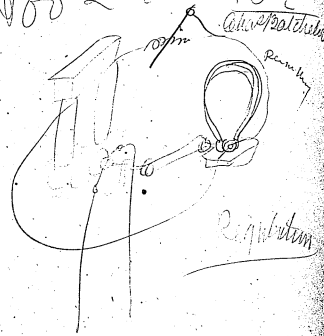


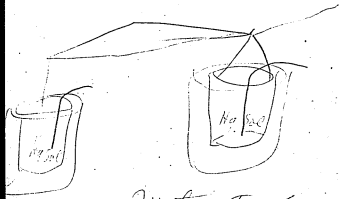
Just

Decomp 40 ft

from Mills.

Nov 2 1880 Tue



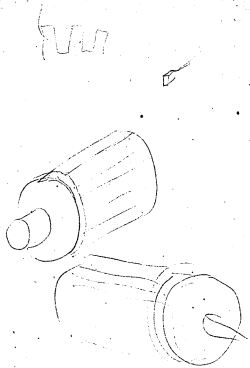


Metu TAL

Nov. 2 1880

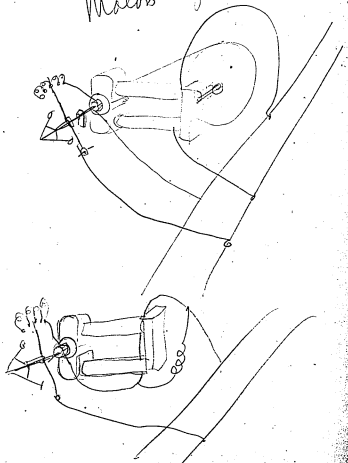
TAL

Charles Patterson



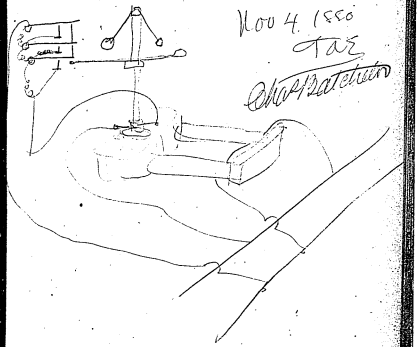
Nov 4 1880 TAE
Patented

Motors Regulation



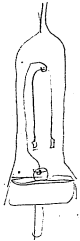
Regulation of Water

Nov 4 1880

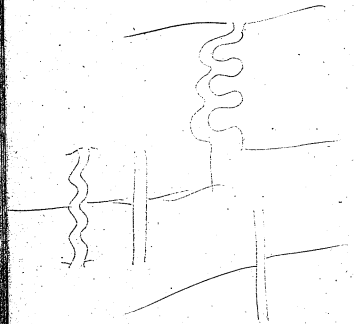


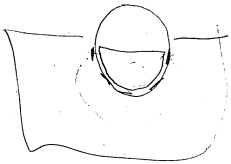
Nov 4 1880

For
Chas Patterson



burners up Clamps





Menlo Park Notebook #63 [N-80-02-08.1]

This notebook covers the period January-June 1880. Most of the entries are by Francis Upton. Included are calculations relating to tests of carbon filament lamps and a few drawings of circuits used for the tests. Other material includes Edison's earliest drawings and notes on the "Edison Effect" and drawings, probably by Charles P. Mott, of vacuum pumps and lamps. The label on the front cover is marked "Carbon Lamps" and "Upton Resistances." The book contains 171 numbered pages followed by 2 unnumbered pages. The pagination is irregular. Sometimes only the right-hand pages are numbered, and some numbers are used for more than one page.

Blank pages not filmed: 171

Missing page numbers: 1-2, 65.

Large Carbon Manilla page 3
Part 0".009 X 0".012 page 13
Bridge page 131

M.O.63

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120 BROADWAY, NEW YORK.

GENERAL ELECTRIC

....., 189

N-80-02-08

3

117 Ohms

D = 235 Lamp 609

W = 105

$$\begin{array}{r} 235 \\ 117 \\ \hline 1645 \\ 235 \\ 235 \\ \hline 27495 \end{array} \qquad 105 \overline{)27495} \; (262$$

210
649
630
195

Carbon of manilla fibre

480 Ohms cold

262 Ohms hot

$\frac{250}{3}$ Volts = 83.3 Volts

N-80-02-08

Tage Carbon Manuelle page 3
Bast 0"009X0"012 page 13
Bridge page 131

M.63

Thomas A. Edison

Columbia Lamps pp. 101 – 113

N 80-02-08

117 Ohms

D = 23 s. Lamp p. 609

D = 10 s.

~~100 Ohms~~ cold

262 Ohms hot

$\frac{250}{3}$ Volts = 83.3 Volts

N 80-02-08

83
83
249
664
6889
443
20667
27558
29372
362) 30494 (27 (1764
262
4229
2202
1674
1572
1027

28 per H.P.

1164) 33000 (28
2328
9720
8148
1572

75 = D

75!

Lamb

115 90 Volts

260

115 : 260 :: 117 : 266

117
820
260
260
115) 30420 (266 Ohms
230
742
690
720

Again 53 Volts

$\delta = 102$

Bichromate cell = 2 Volts
Ohms on resistance box
Divide No. Volts by No. Ohms
result Webers

12000) 6.0000 (.48
5 94 00
7 6 000

.00048 Webers

.51 mg per hour

.00051 gr. per hour

2100
.00051
2100
105
1.2100 Gr. per Weber per hour

.377 Milligr
19) 7.163 (2.3 Milligr per minute
3
3

97
12
194
97
1164

20
60
1.200 Gr. per Weber

90

220

90) 220 (2.44
180
400
360
4

117
2.44
468
468
234
285.48

285 Ohms

125 = 2 .45 Volts

40 =

40 : 125 :: 117 : X

117
525
125
125

40) 14625 (365.6
120
265
240
225
200
25

50 Volts

50 : 140 :: 117 : X

117
9820
140
140
50) 16380
327.6

117
1160
7020
117
60) 15720 (262
120
132
12

55 Volts

60 : 160 :: 117 : X

60
9600
55) 17600 (320
165
110
110
320
320
000

60 Volts

60 : 68 : :

68 : 178 : : 117 :

178
936
819
117

68) 20826 (306.19
204 ×
4 26
408
80

65 Volts

75 : 187 : : 117 : X

187
819
351
117

75) 16027 (213.7
15 0 ×
1 02
75
27
25
2 0
1 5

117
187
819
936
117

75) 21879 (291.7
15 0 ×
687
525
1 59
1 40

70 Volts.

80 : 197 :: 117

117
1379
197
197

80) 23049
288.1

75 Volts

92 : 213 :: 117

213
351
117
234

92) 24921 (271.
184 ×
65-2
64 4
81

80 Volts.

98 : 230 :: 117 : x

117
1610
230
230

98) 26910 (274.6
196
731
686
450
392
580

85 Volts.

~~75 Volts.~~ Resistance 181

175 : 278 :: 181

278
1448
1267
362

175) 50318 (287
350 ××
1531
1400
1318
1225

45 Volts

~~168 : 92 :: 181~~

92 : 168 :: 181

168
1448
1086
181

92) 30408 (331
276 ××
280
276
48

2nd C

50 Volts

102 ; 181 :: 181
181
181
1448
181
102) 32761 (321
306 ××
216
204
121

55 Volts

116 : 202 :: 181
202
362
362
116) 36562 (315
348 ××
176
116
602
580

60 Votes.

90,16811

130 1225,11181
225
905
362
362
130) 4072 5 (33
390 ××
172
130
425
390
35

6/6
36
14
54 6 ohms

1807) 38000 (18 for H.P.
1807
19930

65 Volts

148 ; 245 ;; 181
245
905
724
362

148) 44345 (300
444 ××
945
558
576

7

111
111
111
111
1123.21
44
49284
49284

~~300~~) 542124 (1807

2.5) 542124 (211
500
421
250
1710

$$D = \frac{85}{204 \times 262}$$

$$x = \frac{113}{162\,D} - 6$$

$$= \frac{113}{162 \times \frac{85}{204 \times 262}} = \frac{113 \times 204 \times 262}{162 \times 85} - 6$$

162) 4.16 (.00256
324
920
810
1100

.00256
262
512
1536
512
.67072

.670) 113.0 (1

$162 = D$

28 Volts added
85 + 28 = 113 Volts

$262 \; R = 204$ Ohms

7
5
3.5
1.8
5.3

6 Ohms

324

$$262\,D = \frac{85}{204}$$

$$262\,D = \frac{113}{6 + x}$$

$$D = \frac{.416}{162} = .00256$$

$$x = \frac{113}{262\,D} - 6$$

204) 85.0 (.416
816
340
204
1360

$D = .416$
162
832
416
416
67392

1490) 33000 (22
2980
3260

113
204
452
226
23052
262
462
1386
462
605 2200

162
85
810
496
5770

5770) 605 2200 (115
5770
575
115
1323
44
5290 0
5290 0
5819 00

3 ~~89~~) 5819 00 (1490
3 89
1920
1556
3640
3112

570 (23

4 | 170

320 : 135 :: 204

204

540

270

320 | 27540 (86

2560

1740

1920

20

165 : 310 :: 204

204

1240

620

1.25 | 63240. (383 Ohms Ans

495

1370

1320

500

2.4 inches .2121

.5 40 .005

2.4 length 3 314

.005

2.4 inches length .015570

.005 in diam 24

628

314

.03768

.037 | .2121 (5.7

185

270

259

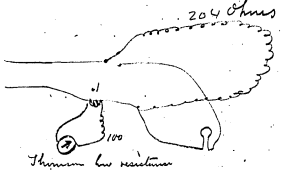
110

86 | 383 | 4
344

264
88 Volts

86 | 343060 | 3988
258
850
774
766
688
780

Regular lamp
marked 145 ohms cold
gave with 88 Volts
86 ohms resistance
Method



Fine light

16.

22 $\sqrt{\ }$

$n = \cancel{8}\sqrt{5}$

$= c\sqrt{5}$

$\cancel{16} : 22 :: \sqrt{2.4} : \sqrt{x}$

16 22

96 44

256 : 484 :: 2.4 :

24

1866

968

256) 1546 (45

1024

1306

1536

a filament .005 inch in diam, 2.4 inches long gives 22 per H.P.

how long to give 16 per H.P.

ans 4.5 inches

~~2.5~~ : ~~4.5~~ :: 389

5 9

3501) 9

900

16) 33000 (2062

32

100

96

40

200

1443400

443) 443400 (32580

1329

1144

886

2580

2115

2360

3 28 50 (181
1
28) 228
224
36) 450

154
1

Gas jet 26.5
26.5
1325
590
530
702.25

Elec light

22
22
44
44
484) 702
484
2180

1.4) 16 (11
14
20

11 candles

20
20
400

28
28
224
56
784

1 07 A.M. Bridge

Meter 1 exactly

1 18

11 minutes

1.20 1/2
7
13 1/2

13.5 : 60 :: .5
.5
13.5) 30 (2.2
22
30

Meter measurement of ordinary gas jet

1.07 d.A	1 foot mark
1.20 1/2 A.M	1 1/2 foot
1.38	2 feet

again
2 15 A.M
3 15 At 2 feet

376) 21.2100 (.572
1580
2710
2580
2630
0780
780
49
1900
572
23
43) 172
129
43.00

Feb. 8

A filament of carbon estimated as .005 inches in diameter
2.4 inches long
had a resistance cold of 505 Ohms
hot " 883 Ohms

Surface .03768 inches

The "regular" horse shoe has a surface of .2121 inches

$.2121 : .3376 :: x^2 : 10^2$

If the number per horse power varies as the square root of the surface the fibre should give 24 where the regular gives 10.

22 small gas jets per horse power

5 inches

1/8 9/72

1/16 5 inches to travel

9 - 2 1/2 6 1/2
1/4

9 3/4 inches

7.75
3.14
3106
775
2325
2 2433350
16 1200 .75 mat
80

38
38
304
114
1444

67
38
27
27
189
54
729

Gas

Kerosene

Valve

.175

5 inches

90 Volts

75 inch

90 ~~150~~ inch

150 mm

$\frac{90}{15} = \frac{3}{5} \times \frac{1}{72} = \frac{3}{360}$

$= \frac{1}{120}$ Volt

0 outside

109.5 (.5

0

Inside $\frac{2.5}{9} = .277$

120000) 27700 (.000 73

.023

9

.0026

023

.0026.) .0234.35 (9

234

9 ft lbs

72

9

648

.0026

.026

120) 277

$\frac{1}{1000}$

$\frac{1}{1000}$

~~1000~~

~~6000.000~~

.023 Volts

$\frac{1}{120}$ 1.00 .00833
40

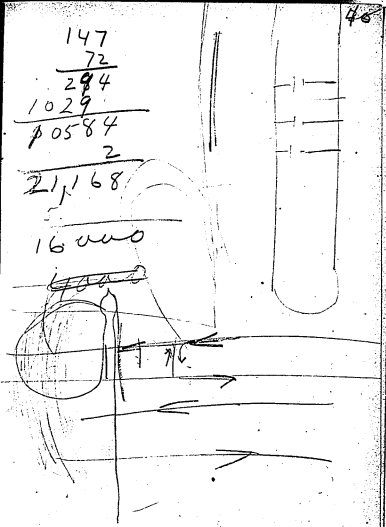
.00938

.00383150

.000026) 003831 (147
26
123
104
191

147
72
294
1029
10584
2
21,168

16000



1 Q = 1

1000 X 1000

1000000 X .000340

4 | 340 lbs.

85

255 lbs.

205 65

143.773 Q. mm.

143 Q.

1 cc = .061 cu. inches

1 mm = .0061 cu. inches

.0061 | .000061 | 163

1000000

16.3

1 cc = .061 cu inches

1 mm³ = .000061 cu inches

1 mm³ = .000000061

.000000061 | 1.000000 | 16300000

1.000.000000

163860

Manilla Fibre

Resistance 262 Ohms

D = 225

D = 360

360 : 225 :: 262

262
450
1350
450
360 | 58950 | 163 Ohms
360
2295
2160
1350

90 Volts

2186 ft. lbs Ga.?

163 | 358830 | 2
326
2

Lamp 634.

Resistance cold 235 Ohms
hot 119 Ohms

80 Volts on lamp
2383 ft lbs
14 per H.P. more than
a gas jet.

Lamp 633 hot 10 Ohms
Resistance cold 390 Ohms
hot 205 Ohms

83 Volts gas jet or
Kerosene oil burner
1520 ft. lbs.
2.46 per H.P.

634 at 14 per H.P.
gas 2383

Cold 235 Ohms
Hot 119 Ohms

215 Ohms = Resistance

360 on lamp

225 on 215 Ohms

360 : 225 :: 215

215
1125
225
050
48375

360
1237
1080
1570

134
15
179
80
134 | 10710 | 80
1072

2383 | 33000 | 14
2383
9170
9532

134 | 33 8830 | 2477
258
908
804
1040
938
1020

119 | 2835 20 | 2383
238
455
357
992
952

252
9
2528 Volts
180.
140) 252 (1.8
140
720

25

2.5
2.5
105
50
6.05

$\frac{8x^2}{8} = \frac{40^2}{1}$

8
40
720 (27
4
4) 320

8100
8
00

133 Full kerosene oil burner 4-16

1520 ft. lbs. 205 ohms

21.6 per H.P. Cold 390 improve 100 ohms

225 on 215 ohm

90 Volts

220.

220 : 225 :: 215 : 220 Ohms

215
1125
225
450

less 15 ohms in line with it.

220) 48375 (219
440
437
220
2170
2980
90

220 Ohms
15
205 ohms

1520 ft. lbs

220 : 205 :: 1:90
90
220) 18450 (84
1760
850
660

1520) 33000 (2.46
3040
2600
1520
10800

205) 312580 (152
205
1075
1025
508
470
400

12 .004

.012

6 fibres .00066 diameter

.000000341 21 3

6

.000000205 26

.000 01

143532 2 358830

1

1 fibre .004 Diam

800

180

25

32 | 283356 (884

256 4

270 3336

256

140

160 Dia

No. 635 Manilla fibre

Resistance cold 342 ohms
hot

245 = Ω on lamp

220 = Ω on

88 Volts

245 : 220 :: 215 :

21

220
4300
430
245) 43300 (193
245
2280
2205
750

88
88
704
704
7744
44
30976
30976
93 34073 (1765
1765
1253
1154
1050
1263

1765) 33000 (18
1765
15350

250
230
210
190
170
150
130
110
90
70

60
50
40
30
20
10

No. 636 Manilla fuse
410 ohms cold
236 ohms hot

220 or 215 ohms

200 1443 ft. lbs.
23 per H.P.

200 : 220 :: 215 :
220
4300
430
273 00
236 ohms

236) 340736 (1443
236
1047
944
1033
944
890

1443) 33000 (23
2886
4140
4329

88.3 : X :: 91.9 : 82.8

88.3
2787
2652
2652
825) 8114.77

828
88.3
2484
6574
6576
91.9) 7255.2 (78
6433
8222

78
78
624
546
6084
918
18252
24336
24336
2695.2

82.8) 26.9521 (3250
2489
2112
1656
4560

32.50) 28.000 (10
3250
500

No. 642 Lamps. 82.8 Ohms hot
1241
73.5 Ohms 3250 ft. lbs Cold
Miscalculated 10 for H.P.
Left .015 Ohms
220 on Lamps + 19.1 Ohms

275 on 73.5 Ohms

3) 265
88.3 Volts

220 : 275 :: 73.5

275
3675
5145
1470

220) 20221.25 (91.9
1980
411
220
192.0

No. 643 162 Ohms Cold
Same as No 642 90 Ohms hot
Very bright 3837 ft. lbs.
8.7 hrs H.P.

220 = D on Camp

280 = Dan. 73.5 Ohms

```
220 ) 280 ( 73.5
      280
      ----
      508800
      1470
      ----
220 ) 19800.00 ( 90
      1980
      ----
```

```
3837 ) 33000 ( 8.7
       30696
       -----
       23045
```

```
      88.3
      88.3
      ----
      2649
     7064
    7064
    -------
    779609
      44.3
    -------
    2339067
   3118756
   3118756
   -------
90 ) 3457922 ( 27
     3837
```

116.4 ! 88.1 !! 2976

2441) 33000 (13.5
2441
8590
7323
12670

116.4) 34539
2328
11359
10476
8830
8148
6820

2976
2976

25808
25808

116.4) 284185.6 (2441
2328
5138
4656
4820
4656
1640

149.5) 33000 (220
2988
412

No. 642 Good kerosene burner 88.1 Ohms hot
2441 for lbs
13.5 per H.P.

178 on lamps and 28.3 Ohms

282 on 73.5

178 ! 282 !! 73.5
282
1470
5880
1470
178) 20727.0 (1764
178
292
178
1140
1068
720

28.3
881

95.4)34539 (3621
2862
5919
5724
1950
1808
1420

3144)33000 (10.5
3144
15600

95.4 : 83.1 :: 3621
831
3621
10863
28968
95.4)3009051 (3144
2862
1470
954
4760
3716
4440

No. 642 Equal to 534

Resistance 83.1 Ohms Cut
3144 ft. lbs
10.5 per H.P.

215 = 2 on launch + 12.3 Ohms
282 = 2 on 73.5

215 : 282 :: 73.5
282
1470
5680
1470
215)20527.0
1935
1177
1075
1095
820

95.4 Ohms
12.3
83.1

80.8) 34 539 (4214) 33000 (7.7
32 32
2219
1666
1153
808
3050

29698
330 20

250 on lamp

275 on 73.5

265
88.3

250 : 275 :: 73.5
275
36 75
5145
1470
250) 20 2125 (8.1
2000
121.25
1000
21.25

80.8 ohms

Feby 13. 1880

Following experiments are for the prevention of carrying by electrification of the Carbon from one side of the Carbon horseshoe

70

80

90

100

110

130

1400

160

190

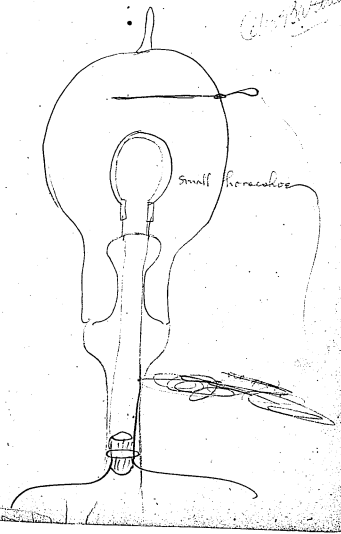
200

210

215

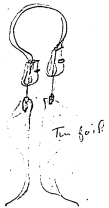
Experiment No. 1. Feby 13 1880

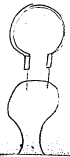
53



Feby 13 1880.

Large globe small horseshoe

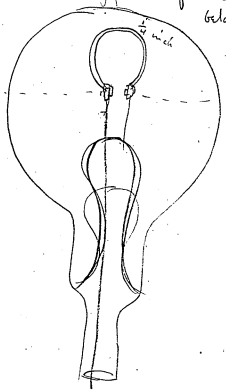




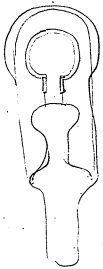
carbon coated with an oxide, say alumina or lime,

Feby 13 1880 87

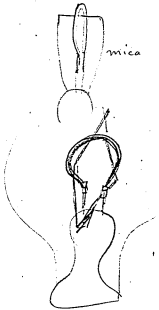
Put up near top to ascertain if coloration goes below dotted line

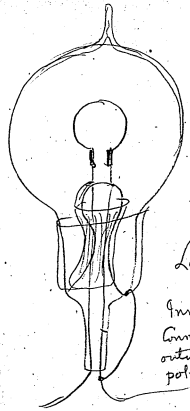


Small globe to ascertain if coloration rapid & to develope other phenomena.



Mica partition, or glass.
Small Carbon

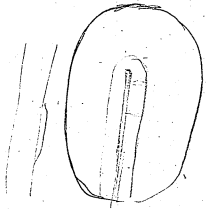




Leyden jar

Inner foil
Connected to one pole
outer foil to other
pole - idea -
Contrary effect of electrification

Distant Sound



108 Sansevieria Cylindrica.

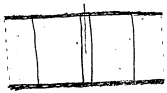
First Class, flat. fibres, shewing blocks – made up of many fibres. – fibres not broken. upon looking closer I find the outer fibre is round, and one fibre twisted on the other like a rope but with a long turn = This might to be a 1st Class fibre

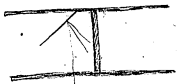
Sansevera Zeylanica, horrible bad
fibr. neg.

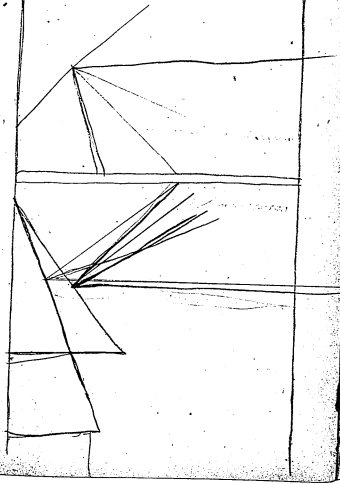
7. Sansevera Cylifolia.
fair regular - [illegible]
fibre but coarse fibre

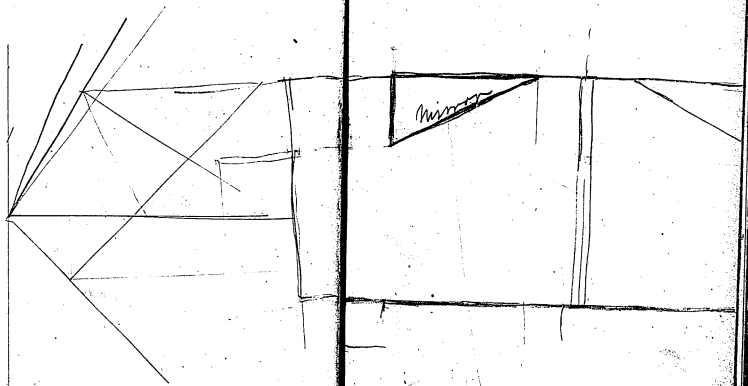
Pineapple fair
good as shoal
fibres, Cultivated

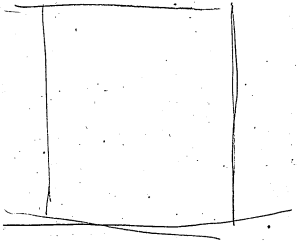
& Daisevera Cylindrica
Opleuda —











18.5
~~8.5~~
200
61.5

18.5
18.5

342.25

37822.5

342)3782 (11.0
342
362
342
2000

22 Candles.

17

3.10
2.29
41

60
23
57

23
23
69
46
5.29

57
57
399
285
32.49

5.29)3249(6.1
3174
750

Good gas jet
12.2 Candles

29m 15sec

At 30m the acc hand 40

at 31 30sec

12 grams.

second hand up

12 — 40
48
8

130
700
8 | 30
3.7

120
6 | 248 Grams
4

465 28

65302
26128
39182

76

$8x^2 = (80 - x)^2$

$8x^2 = 6400 - 160x + x^2$

$7x^2 + 160x = 6400$

$x^2 + ( ) + \left(\frac{160}{7}\right)^2 = 914 + 914$

915
1829

914
328
1485) 38

$x + 22.7 = 33.4$

$x + 22.7 = 38$

$x = 22.7 \pm 38$

22.7
601
293

38
22.7
15.3
747

23409
558009

37249) 361201) 8
297992

$\cancel{x^2 = 8(80 - x)^2}$

$8x^2 = (80 - x)^2$

$= 6400 - 160x + x^2$

$7x^2 + 160x = 6400$

$x^2 + 22.85x = 914$

$x^2 + ( ) + (11.42)^2 = 914 \pm 130 = 1044$ or 784

$x + 11.4 = 32$

$x = 32 - 11.4 = 20.6$

11.42
11.42
2284
4568
11.42
130441 64

1044) 32
9
144

59.4
4

42436
35.2836

424) 3528) 8
3392
1360

$3^h\ 17'\ 43''$

240 grains

$3^h\ 48'\ 15$

120 grains

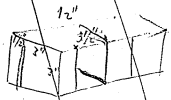
3	48	15
	17	43
	30	30

30.5) 120 (3.93
915
2850) 11790
2745
1050

117.9 grains an hour

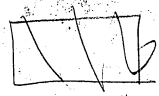
Make box 3" X 4½" X 12"

Make ends open on one side 3" X 3"

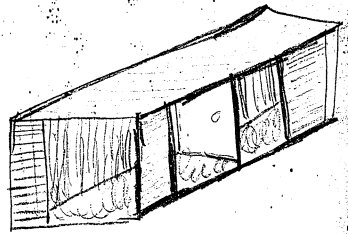


3½" opening on each side of screen

Make arrangement of to brass plates to hold screen



Matchbox
3" X 1 1/2" X 12" inside



Make box 3" X 4 1/2" X 1.2"

Make slide for paper from the front

Hold the box in frame and mount like picture in gas lighting so that the whole arrangement

May be moved back ~~[illegible]~~

L. R. Upton,

Fairchie armature

no cover. .014 in plates
.001 tissue paper

240 after 15 minutes
26
320 after 45 minutes

45) 80 (.18
45
350
350

14167
.18
113336
14167
2650.06

25.50) 32000 (13
25.50
7500
7650

1/12 H.P.

15/8

8 2/8
1 5/8

9 7/8
1 5/8

6 1/2

.0353
14
1412
353
.4942

23

7.4 in
area 43
11
43
43
473) 1728 (36
1419
3090

1 Litre = How many cu. ft

1 Litre = .0353 cu. ft.
8 litres
.2824

7 Litres
6 1/2
27 1/2

.0353
275
1765
2471
706
.97075

Test gas burner

5 hr. 47' ⊙

1 3/4 6 h 7
5 47
20

20 minutes 1 3/4 feet
60 " 5 1/4 feet

London Argand

9 - 41 P.M.

1 ft

10 - 47 2.60
9 41
36 minutes

36 : 60 :: 216 :
60
36) 156.0 (4.33 feet per hour
144
120
108
120

10 - 38 4 feet
9 - 41
57 : 60 :: 48
6
57) 240 (421 feet per hour
228
120
114
60

12h. 30′ – 30″

1730 grains
40
1690

12h 40′ 55
12 30 30
10 25

10 : 10.4 :: 1

10.4 : 10 :: 120

104) 120 (1.511 grains per hour
104
160
104
540
520
200

60) 25 (.401
24
100

1690
80 grain
1670

12h 58'

12h 58
12 30
28

~~28 | 28 ::~~

28 : 27.5 :: 120
120
5500
275
28) 3300.0 (117.8 grains
28
50
28
220
196
240

586
214) 58.6 (2.74
428
1580
1498
820

2.74
2.74
1096
1918
548
7507.6
2
15.6

Large flame
15 candles

62
18) 62 (3.44
54
80
72
80

3.44
3.44
1376
1376
1032
11.83 36
2
23.66

23 2/3 candles
Full flame

541

259) 5401 (209

518

2300

207
207

1887

418818

4198861

2

4198

2

8.38

8.38 candles

518

282) 518 (1.84

282

2360

2256

1040

1.84
1.84

736

1472

184

338 56

2

6.76

6.76 candles

6.76 candles tested against two candles
7.02 " " " " one "

581

219) 581 (2.65

438

1420

1314

1160

265
265

70225

7.02 candles

Last flame with one candle

E.L.

534

266) 534 (200

532

200

4

8 candles flat wick

120 Lamp Regular ?
190 R

120 : 190 :: 93
190
63 70
93
120) 1 70 (1.41 Ohms
120
567
870
870

3) 282
94 Volts
94
366
846
8826
443
26478
64

147) 383 (2.58
294
891
735
1560

2560 ft. lbs. 8 candles

2560) 33000 (12.7 per H.P.
2560
7400
5120
22800

42
38) 42 (1.10
38
40
38
20

11
121
2
2.41 Candles

105 : 155 :: 93
93
465
465
105) 1441 (1.37 Ohms
105
391
315
765

100 : 160

~~94 : 170~~ Connecting wire .165 Ohm

120 : 190

108 : 155 :: 93

93

465

1395

108) 14415 (7

108

361

~~105 : 150~~

120

115 : 200

110 215 165 Ohms

125

120) 215 :: 93

93

645

1935

12) 19995

1666

166) 283000 (1700 ft-lbs

166

1170

1162

80

170 : 256 :: 2.41 :: — 2.41 Candles

60.5

19.5) 60.5 (31

585

200

31

31

31

93

961

2

19.2 Candles

172 : 225 ::

175 : 245

205 : 390 :: 93 :

93

870

2610

205) 26970 (1000 Ohms

205

647

638

970

150 : 225 :: 93 Regular

93
675
2025

150) 20925 (135 Ohms
150
592
450
1420

150

3 (315 Volts
105

9 : 175 ::

3440) 33000 (9.6
30960
2040

119 : 162 :: 93

93
546
1638

119) 10926 (142 Ohms
119
562
476
860
238
2

142) 485.400 (3440
426
624
568
560

94 Volts

102 : 164 :: 93 Regular

93
492
1476

(102) 15252 (149 Ohms
102
505
408
972

149) 391449 (2626
298
934
894
404
298
1060

2626) 33000 (12.5
26260
6740
5252
14880

12.5 8 candles

80 Volts.

85 ; 139 ; 93
93
417
1251
85) 12977 (152 Ohms
85
442
425
177

; 138 ; 145 ; 93
93
435
1305
34 ; 13485 (97.7 Ohms
1242
1365
966
990

255
85

22
5
17.6

68.5
185) 6155 (332
555
600
555
450

332
332
664
996
996
110224
2
22 candles

97.7) 20.070 (32.70
2931
2697
1954
7430

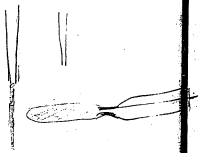
32.70) 33000 (10.2
3270
8000

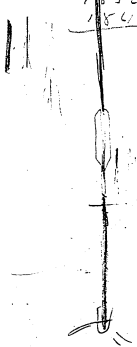
56.1
23.9)56.1 (2.34
478
830
717
1130

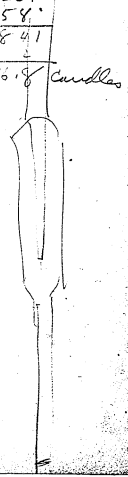
234
234
936
702
468
54756
2
16.94

59.5
205)59.5 (29
410
1550
1845

29
29
261
58.
841
2
10.8 Candles







83 volts

59.7
3

17 scale for resistance
10 lamps

137 ⊗ 147
10 17
127 : 130.93

127 : 130 : 93
130
2790
93
127) 12090 (93 Ohms
1143
560

93) 305 180 (328
279
268
186
850
32

156 170

March 6 Lamp 774
2-30 A.M. R 207

Took about 40 grains
2 39 40

48.75
57.2
2.8 95
49.47

30.53) 49.47 (1.6
30.53
1894
16
96
16
25

108.166.93.5
5.35
530
28
2

12) 155.210 (144 Ohms
12
35
32
472
432
501

144) 3568000 (2480
288
708
576
1220
2

2480) 33000 (13.3
2480
8200
7440
7600

13.3 per H.P.

Candles 5.12

100 80

.07) 100.00 (
1428.

1/1000

.008 in

1428
.0971
1428
9998
12852

9.718
.0971

4) 138608 Ohms
34.8 Ohms
2
69.6 Ohms

49

50.25 Broad side
50.75
51.00

5.7 Candles

10°

Its change 5.7

20° 50.75 5.7

30° 50 3/8 5.5

40° 56 5.24

50°

48 3/4 4.50

60° 47 1/2 3.92

70° 45 3.38

80° 42 2.41

1.80

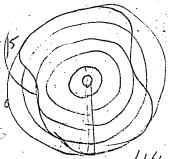
506
294) 506 (1.68
294
2020
1764
2560

1.68
1.68
1344
1008
168
2.8224
2
5.7

20) 50 (162
50
200
160

162
162
324
972
162
26244
2
5.24

48.75
31.25) 48.75 (1.5
3125
17500
1.5
2.00



1.5
1.5
75
1.5
2.25
2
4.50

47.5
3.25) 47.5 (14
325
150 0

114
14
56
456
2
37.2

38 | 4.2 (1.1
2.8
20
12
2
2.4

4.5
35) 4.5 (1.3
35
100
35
35

112 ; 168 :: 93.3

935
840
509
1512

112 | 15708.0 | 140 Ohms
112
450
448
28

108 : 165

500

571 : 500 : 820 : 50

5.7 | 25.000 | 4.4
228
220

570 | 5000 | .877
4560
4400
3990
4100

241
877
1687
1687
928
113571385

.877
524
3508
1754
459548

.877
55
4385
4385
4823.5

.877
45
4385
3508
39465

577
392
1754
7893
2631
343785

.877
55
4385
4385
4823.5

.877
524
3508
1754
459548

.877
45
4385
3508
39465

577
392
1754
7893
2631
343785

82

2366
2366
2704
296426

6×400

600
100
200
100
100
280

1380

70% of the light from the

broad side 250
314

70%

1000
250
750

4 | 7850.0

1980 | 1380.0 (70
1386 0

$$x^2 = n(80-n)^2$$

$$x^2 = \cancel{80n} \quad 80$$

$$6400n - 160nx + nx^2$$

$$x^2 - nx^2 + 160nx = 6400n$$

$$(n-1)x^2 - 160nx = -6400n$$

$$x^2 = \frac{160n}{n-1}x + \left(\frac{80n}{n-1}\right)^2 =$$

$$= + \left(\frac{80n}{n-1}\right)^2 - 6400n$$

$$\cancel{80n \quad \frac{80n^2 - 640n^3}{n^2 - 2n + 1}}$$

$$x = \frac{-80n}{n-1} = \pm\sqrt{\left(\frac{80n}{n-1}\right)^2 - 6400n}$$

$$x = \frac{80n}{n-1} \pm \sqrt{\left(\frac{80n}{n-1}\right)^2 - 6400n}$$

$$x = \frac{80n}{n-1} \pm \sqrt{\frac{80n^2}{n-1} - 6400n}$$

$n = 1$

$x = 48$

$\cancel{x = \frac{80n}{0}}$

80

$x = \frac{1}{2}$

$$x = \frac{40}{-\frac{1}{2}} \pm \sqrt{}$$

$$= -80 \pm \sqrt{6400 - 3200}$$

$$x = -80 \pm \sqrt{3200}$$

$$x = -80 + 56.5 = -23.5$$

84

$$x^2 = (80 - x)^2$$

$$= 3200 - 80x + \frac{x^2}{2}$$

$$\frac{x^2}{2} + 80x = 3200$$

$$x^2 + 160x = 6400$$

$$x^2 - 160x - 6400 = 12800$$

$$x = -80 \pm \sqrt{}$$

$$\begin{array}{r} 160 \\ 160 \\ \hline 960 \\ 160 \\ \hline 2560 \end{array}$$

$n = 2$

$$x = \frac{160}{1} \pm \sqrt{25600 - 12800}$$

$$\begin{array}{r} 25600 \\ 12800 \\ \hline 12800 \end{array}$$

$$= 160 \pm 113$$

$$x = \begin{array}{r} 113.1 \\ 47 \\ 47 \end{array}$$

3.3

$$\begin{array}{r} 47 \quad 2209 \\ 33 \quad 1089 \\ \hline 2198 \end{array}$$

$1549 \quad 1369$

4 candles

46.9

33.1

$$x^2 = n(80-x)^2$$

$$x^2 = n(6400 - 160x + x^2)$$

$$= 6400n - 160nx + nx^2$$

$$-nx^2 + x^2 + 160nx = 6400n$$

$$(n-1)x^2 - 160nx = -6400n$$

$$x^2 - \frac{160n}{n-1}x + \left(\frac{80n}{n-1}\right)^2 = \left(\frac{80n}{n-1}\right)^2 - 6400n$$

$$x - \frac{80n}{n-1} = \pm\sqrt{\left(\frac{80n}{n-1}\right)^2 - 6400n}$$

$$x = \frac{80n}{n-1} \pm \sqrt{\left(\frac{80n}{n-1}\right)^2 - 6400n}$$

$$n = 2$$

$$x = 160 \pm \sqrt{160^2 - 6400}$$

$$\frac{2}{12800}$$

85

160
160
9600
16
2560 00
1280 00
1280 00

$$x = \frac{80n}{n-1} \pm \sqrt{\left(\frac{80n}{n-1}\right)^2 - 6400n}$$

$$n = 1.5$$

$$n - 1 = .5$$

$$\frac{80n}{n-1} = 2400$$

1.5
00
12016
2
2400
2400
576 0000
1960
6400 48000
1.5
32000
64
96 0000

6

$$x = 240 \pm 219 = 21 \quad 459$$

21
21
42
441

$$80 - x = 59$$
59

$n = 1.5$

$x^2 = 1.5(80 - x)^2$

$= \frac{3}{2}(6400 - 160x + x^2)$

$2x^2 = 19200 - 480x + 3x^2$

$x^2 - 480x = -19200$

$x^2 - ( ) + 57600 =$

$x^2 = 240 \pm \sqrt{38400}$

$240 \times 240 = 9600$

$480 \times 80 = 38400$

19959

4491

85.9

2025
1225
61
1835

1994
1288
644
1932

$n = 1.5$

$x^2 = n(160 - x)^2$

$x^2 = n(6400 - 160x + x^2)$

$= 6400n - 160nx + nx^2$

$x^2 - nx^2 + 160nx = 6400n$

$(n-1)x^2 - 160nx = -6400n$

$x^2 - \frac{160nx}{n-1} + \left(\frac{80n}{n-1}\right)^2 = \left(\frac{80n}{n-1}\right)^2 - 6400n$

$x - \frac{80n}{n-1} = \pm\sqrt{\left(\frac{80n}{n-1}\right)^2 - 6400n}$

$x = \frac{80n}{n-1} \pm \sqrt{\left(\frac{80n}{n-1}\right)^2 - 6400n}$

$n = 1.5$

$\frac{120}{2} = 240$

$\frac{80n}{n-1} = 240$

$$(n-1)x^2 - 160nx = -6400n$$

$$x^2 - \frac{160nx}{n-1} = \frac{-6400n}{n-1}$$

$$x^2 - (\quad) + \left(\frac{80}{n-1}\right)^2 = \left(\frac{80n}{n-1}\right)^2 - \frac{6400n}{n-1}$$

$$= \frac{6400(n-n)}{(n-1)^2}$$

$$= \frac{6400}{n-1}$$

$$= \frac{6400n - 6400n^2 + 6400n}{(n-1)^2}$$

$$= \frac{6400n(-n^2+n+1)}{(n-1)^2}$$

$$= \left(\frac{80}{n-1}\right)^2 - \frac{6400n}{n-1}$$

$$x = \frac{80n}{n-1} \pm \sqrt{\left(\frac{80n}{n-1}\right)^2 - \frac{6400n}{n-1}}$$

$n = 1.5$

$$\frac{80n}{n-1} = 240 \pm$$

$$\frac{n}{n-1} = \frac{1.5}{.5} = 3 \qquad \frac{6400}{3} \quad 19200$$

$240^2 = 57600$

19200

$\sqrt{38400} = 195.9$

$x = 240 - 195.9 = 44.1$

$80 - x = 35.9$

3 candles 44.1

2 candles 40.

4 candles 46.9

$n = 2.5$

$$x = \frac{80n}{n-1} \pm \sqrt{\left(\frac{80n}{n-1}\right)^2 - \left(\frac{6400n}{n-1}\right)}$$

2.5
80
2000
15
300

$\frac{80n}{n-1} = 300$

$(\ )^2 = 90000$

10666
7934

6400
2.5
3200
128
16000 (10666
15
100

300 281

15) 200 (133
15
50
45

17800
10666
7134 (84.4
64
164) 734
656
16.8) 7800

84.4

$x = 133 - 84.4 = 48.6$

$80 - x = 21.1$

44521
23921

88

71 34 (84.4
64
164) 734
656
16.8) 7800

84.4

$$x = \frac{80n}{n-1} \pm \sqrt{\left(\frac{80n}{n-1}\right)^2 - \left(\frac{6400n}{n-1}\right)}$$

5 inch belt
10 inch pulley

1000 revs
12 | 31400
2617 ~~ft. lb~~ ~~ft/min~~

1 inch 600 ft/min 1 H.P

600 | 2617
4.36 H
5
21.60 H.P.

5 inches

2 | 31.4
15.7
5
78.5

| 2617
1308
78.5
6540
10464
9156

33 revs | 102.6 78.0 | 3.1
99
36

3.1 H.P.

$$w = \frac{H.P. \times 3660}{r \times c}$$

$$H.P. = \frac{w r c}{3660}$$

144) 78.5 (.54
~~720~~
720
650
556
940

w = ~~90~~ 5

r = 2617

c = .548

548
5
2740
2617
19180
2740
16440
5480

3660) 2770.580 (1.9
3660
3510

90

$$x = \frac{80n}{n-1} \pm \sqrt{\left(\frac{80n}{n-1}\right)^2 - \left(\frac{6400}{n-1}\right)}$$

$n = 2.5$ $\quad n - 1 = 1.5$

80
1.5) 200.0 (133 $= \frac{80n}{n-1}$
1.5
50
45

$133.3^2 = 17700$
10666
7034 (83.8
64
1636
489
14500
13

64
2.5
32000

228
1.5) 150000 (10666
1.5
00000
20
13

$x = 133.3 - 83.8$
83.8
49.5
205

5 candles

$n = 3$ $\quad n - 1 = 2$

$$x = \frac{80n}{n-1} \pm \sqrt{\left(\frac{80n}{n-1}\right)^2 - \left(\frac{8400n}{n-1}\right)}$$

$2 \overline{)240} = ()^n$ $\quad 14400 = ()^2$

$2 \overline{)6400}$ $\quad 9600$

3200 $\quad \sqrt{4800} = 69.28$

3

9600

120

69.28

501.72

6 candles 19.28

$n = 7$ $\quad n - 2 = 5$

$$x = \frac{160n}{n-2} \pm \sqrt{\left(\frac{160n}{n-2}\right)^2 - \frac{25600n}{n-2}}$$

$x =$ $\quad 160$

$5 \overline{)1180}$

236

$256\,00$ $\quad 55696$

7 $\quad 35840$

$5 \overline{)179200}$ $\quad 19856$ $\quad 1725$

35840 $\quad 37 \overline{)198}$

189

$342 \overline{)956}$

684

$344 \overline{)17200}$

236

172.5

$2 \overline{)63.5}$

31

$$x^2 = n(160-x)^2$$

$$x = \frac{160n}{n-1} \pm \sqrt{\frac{160n}{n-1} - \frac{25600}{n-1}}$$

$n = 7 \qquad n-1 = 6$

160
7
6 | 1120
186.6

186.6
186.6
1059.6
1059.6
1492.8
1866
34753.56

256000
7
6 | 1792000
29866

29866
4887 | 69.9
34
829 | 1287
1161
126 | 12800

186.6
69.9
2 | 267
88

92

Double current
Quad heat

1/2

1 X 1 X 44 ÷ 1 gm = 44.

1/4

1/4

1/16

1/16

1 volt = 1 volt gm. = 1
heat. 1 volt

1/2

2 inc 1/2

1/4 volt

3/4

1/4

1/4

1/4

1/16

3/16

1/16

C 2/11 = 1/1 =

gm = 2

4

2

2

1 volt

1/2

1 volt switch

2

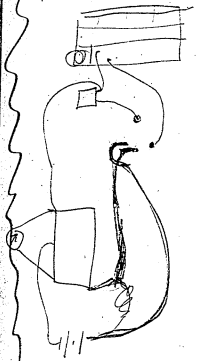
1 volt

1/2

2 volts

1/2

2 + 2 = 4



Brushes put up. in charge on the dip

Results Photometer

Fibre coated with plumbago

Resistance hot 57.4 Ohms

Candles	Broadside	19	candles
	Edge	16	"
	Average	18	"

Total lbs consumed 3003

11 per H. P. in current

176 candles in 11 places

Resistance hot 54.7 Ohms

Broadside	24.5	candles
Edge	20	"
Average	23	"

3600 ft lbs

9.1 per H. P in current

211 candles per H. P.

in 9.1 places

Regular large carbon No 618 [illegible]

Resistance hot 87.7 Ohms
cold 150. —

Broadside 20 candles
Edge 8 — .
average 15.4 —

Consumed 4320 ft. lbs.
7.6 w H.P. in current

114 candles in 7.9 places

Remarks Perfect carbon, has burned 1000 hours, glass moderately clear. No sign of impurity at end heat

Small carbon No. 813

Resistance hot 112.4 Ohms

Broadside 25 candles

Commercial 3246 ft. lbs.

10.16 per H.P.

another small lamp another time.

broadside 23.5 candles

8 per H.P.

188 candles broadside in 8 places

142 on average

Bark fibre lamp No. 705

Resistance cold 225 Ohms/hot 122.5 Ohm

Broadside 15 candles

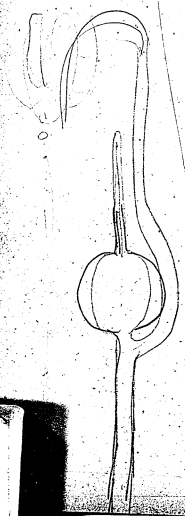
Average 14 candles

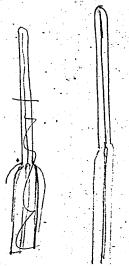
3840 ft lbs

8.6 per H.P.

120. candles in 8.6 places

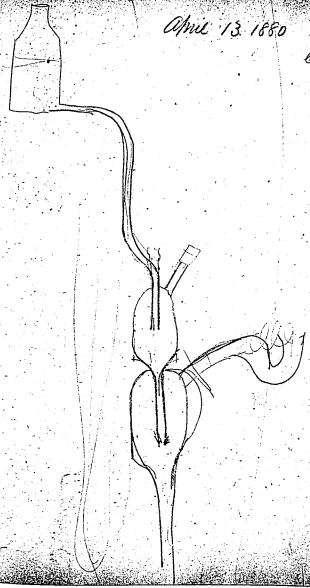
April 13 1880



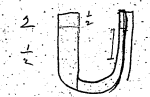


April 13 1880

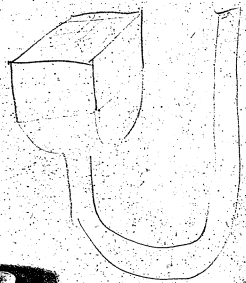
bem



1 lb.
10 ft.



120 –



Candles	Deflection
22	130
17 1/2	120
15	125
15	115
15	115
11 1/4	100
11	112
10	
9 3/4	102
9 1/2	108
9 1/4	90
8 3/4	
8 1/2	
8 1/4	

Pt. wire .005 in. in diameter?

~~[illegible]~~ $R = 1.8$ ohms

five cells of condit and Hanson

21 on photo against 1 candle

$$\begin{array}{r} 21 \\ 21 \\ \hline 21 \\ 42 \\ \hline 421 \end{array} \qquad \begin{array}{r} 59 \\ 59 \\ \hline 531 \\ 295 \\ \hline 3481 \end{array} \qquad \begin{array}{r} 8.2 \\ \\ \\ \\ \\ 3368 \\ \hline 1130 \end{array}$$

$\frac{1}{8.2}$ candle

16½ candles face

L.R. 198

H.R 295

on 81.5 Ohms 235 =

2

85
255

New loop carbon lamp

all 12 candles

	H.R.	L.R.	
1	280 ✓	192	219 on 81.5 ohm
2	272 ✓	192	289
3	299 ✓	179	
4	265 ✓	185	265 H.R 205 L.R
5	290 ✓	172	
6	275 ✓	185	
7	276 ✓	185	
8	287 ✓	175	
9	278 ✓	185	
10	290 ✓	172	
11	290 ✓	178	
12	275	188	

No 1

280 192

216 2.3445

81.5 1.91116

Amt 192 7.71670

91.7 Ohms 1.96231

3 | 250

93.3 Volts 1.96988

1.96988

1.64640

8.03769

3.62385

4200 4.51851

7.8 .89466

272 H. R

192 L. R

No. 2

~~3.33445~~

~~1.91116~~

91.7 Ohms

90.6 Volts 1.9574

1.9574

1.6464

8.0377

3970 3.5989

5.1855

8.3 .9996

299 H. R

179 h. R

232 on 81.5

232	2.3655
81.5	1.9112
comp. 179	7.7471
	2.0238

100 Ohms

99.6 Volts	1.9983
	1.9983
	1.6464
	7.9762
	3.6192
4160	4.5185
7.9	.8993

265 H. R

185 h. R

205 on 81.5 Ohms

205	2.3117
81.5	1.9112
comp. 185	7.7338
90	1.9557

88.3 Volts	1.9460
	1.9460
	1.6464
	8.0443
3830	3.5877
	4.5185
8.6	.9358

290 H.P.

172 L.R

225 ohm 81.5

225	2.3522
81.5	1.9112
amps 172	7.2645
	2.0279

100

96.6 Volts	1.9850
	1.9850
	1.6464
	7.9721
3880	3.5885
	4.5185
8.5	.9260

275 H.P. No. 6. 107

185 L.R

214 ohm 81.5 ohms

214	2.3304
81.5	1.9112
amps 185	7.7328

94.3 ohms 197.4

91.6 Volts	1.9619
	1.9619
	1.6464
	8.0256
3940	3.5958
	4.5185
8.4	.9227

4000 ft lbs No. 7

8.4 per H.P.

No. 8

287 H. R

175 L. R

212 on 87.5

212	2.3263
87.5	1.9421 2
comp 175	7.7570
	1.9945

98.7 Ohms

95.6	1.9805
	1.9805
	1.6464
	8.0055
	3.6129

4100

No 9

278 H. R.

185 L. R.

215	2.3324
87.5	1.9112
comp 185	7.7328
	1.9764

94.6 Ohms

92.6	1.9666
	1.9666
	1.6464
	8.0236
	3.6032

4010

No 10

290 H.R.

172 L.R

225	2.3522
81.5	1.9112
comp 172	7.7645
	2.0279

106 Ohms

96.6 Volts 1.9850

1.9850

1.6464

5.6164

7.9721

3.5885

3880

No 11

290 H.R

178 L.R

225	2.3522
81.5	1.9112
comp 178	7.7496
103 Ohms	2.0130

96.6 Volts 5.6164

7.9860

3.6024

4000

No. 12

275 H.R

1.88 L.R

212	2.3263
81.5	1.9112
Comp 1.88	7.7257
	1.9632
92	
91.6	1.9619
	1.9619
	1.6464
	8.0368
40 40	3 6070

Table for large comp mean May 1, 1880. Other lamps all gave 12 candles

Ohms	Foot lbs	12 candles per H.P.
No. 1 93.3	4200	7.9
2 90.6	3970	8.6
3 100	4160	8.5
4 90	3830	8.4
5 100	3880	8.4
6 94.3	3940	
7 94.3	3940	
8 98.7	4100	
9 94.6	4010	
10 106	3880	
11 103	4000	
12 92	4040	
	12 | 47950	8.44
	3912	

4.5185
3.5922
8.9263

Wood lamp cut from veneer .020 in. thick 1030 ohms cold

77 ohms in resistance

H.R	L.R. on 77 ohms
258	191
265	198
280	204-206
301	221
268	197
245	180
219	161

780

May 4

220 : 187 :: 77

77

13.09

1309

224) 1439.9 (6.5 ohms

132

119

110

9

On lamps

HR	LR		Candles
210	173 - 174		2
208	172		2
212	178		2.5
224	189		3.6
230	200	Face	4.7
248	220	Edge	3.25
			7.6

on 77 ohms 187

276	250	17.25
273		

78 ohms

May 4

179

82
52
164
156
672 64
48
26896
26 56
2958 56 | 85300
56
2840
1 58

~~245 : 180~~

180 : 248 :: 77

1 3 6
1 2 4

180 | 1896

248 : 180 :: 77

180
6160
77
248 | 13860 | 56
1240
1466

Wooden lamps
28 candles

285 on L.R
276 on H.R.

	L.R.	H.R.	Candles
		champs hut	
1	248	245	12
2	264	242	12
3	250	234	
4	237	237	12
5	335	280	12
	1228	1238	
	246	248	

~~245~~

237 : 186 :: 77

1.8865
2.2695
7.6253
60.4 Ohms 1.7813

237
99

1.8976
1.8976
1.6464
8.2187
45 60. 3.6603

Thomas A Edison

June 9 1880

11 candles test fitting

3)250
83.3

1.9206
1.9206
1.6464
8.0336
3.5212
1.0414
2.9798

301 ft. lbs.

110 : 117 :: 87

1.9395
2.0682
7.9586
1.9663

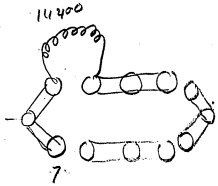
15 candle 8 per H.P.

110 candles per H.P.

110)33000
300 ft-lbs. per candle

4 Volts will make about 3½ candles difference in a lamp which is giving 8 per H.P. of 15 candles

Lamps in bridge



126.40
22.20
7.60
156.20
78.10

12.640
2200
14840
7300
22140
110.70 Ohms

Wooden Camp

14.840
50
14890
74.45 Ohms Burst

14 840
6 000
20840
104.20

14.840
5880
20960
104.80

20 Volts

20 840
6300

Volts	
26	5600
32	4600
66	1700
80	~~1500~~ 1450
90	720

6300
2
12600
1400
14000

12600

12600
3
37800
2200
40000
4000
44000
220.

E.M.F
15 Volts 220 Ohms
First light red
26 Volts 202 Ohms

702
200
140400

14020
12620
1400
14020

Bast 0".009 X 0".012

May 14. 80

Lamp 1135 Bast fibre, cut from large fibre by new clamps made by Bradley & Hubbard Mfg Co

1135 240 Ohms

1136 225 Ohms

W. N. Boxes 0".009 X 0".012 before carbonizing

Box 1 6250 end connection bad

6250

12500

Box 2 6285

6295

12580

Box 3 6330

6290

12620

Box 4 6290

6297

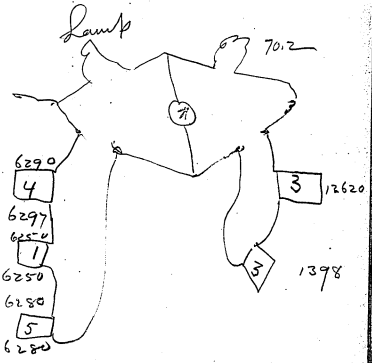
12587

Box 5 6280

6290

12570

No 1135



12579
12587
12800
37666

Lamp No. 1135

117

37660
02220
39880
3580
43460
217.30

Volts
3 | 47
15.6

3 | 72.15

Just red

217.3 Ohms

39880
1050
40930
204.65 Ohms

39880
6250
33650
6200
39830
199.75

3 | 87

15
8
120

100) 33 and
275 ft. lbs.

4:
5.44
9.44

1/4 more candles for total
1/3 more — for candle burning to much

$1/4 + \frac{1}{3} = \frac{7}{12}$ more to add

19 | 1.2788
1.0792
.1996

86	1.9345	3.16	.4997
88	1.9345		.1996
44.3	1.6464	5	.6993
Comp 158.55	7.8113		
	3.3267		

5 | 2120
424

Lamp No 1135
Raffing Camp no diff 137
Volts
100
33.3

33.630
5200
385830
194.15 Ohms

Yellow
3 | 135

33630
3000
36430
182.15 Ohms

3 | 225
75

33630
6250
273880
53760
327500
163.75 Ohms

| 2.5 gl
257 R

3 | 258
86

27380
4390
37770
158.85 Ohms

In all 64.7 R
65.5

$3\frac{1}{6}$ candles

5.5
2.7
8.2

1250
93 1.9685
93 1.9685
1.6464
154 7.8125

2450 3.3959
5.185
7.1226

4
6021
.1996
6.33 .8017

B.2

90 1.9542
90 1.9542
64.3 1.6464
Comp 156. 7.8069
3.3617
.8017
2.5660

360 ft lbs per candle

6.2 .7924
.1996
9.8 candles 9.920

97.3 1.9881
97.3 1.9881
1.6464
153.4 7.8141
3.4367
.9920
.4447

278 ft lbs per candle

257 L
2 7/8 candles
158.55 Ohms

1270 L
90 Volts
27380
3900
31280
156.40 Ohms

270 R
4 candles

282 R
11-39 2
3500 Ohms
154.40 Ohms
5 1/2 candles
285 L

293 L
11-42
3200 Ohms
153.40 Ohms

292 R
11-44
6.2 Candles

108.1
108.1
44.3
Camp 147

2.0338
2.0338
1.6464
7.8327
3.5467

3530 ft lb

4.5185
3.5467
.9718

9.37

~~118.6~~
~~118.6~~
~~44.3~~
~~146.9~~
~~4230~~
~~7.8~~

~~2.0738~~
~~2.0738~~
~~1.6464~~
~~7.8328~~
~~3.6260~~
~~4.5180~~
~~8915~~

171.2304
0.1996
14300

27 candles all round

295 L Lamp No. 1135 141

11-46 325 L
108.1
21560 Ohms

27380
2150
29530
147.65 Ohms

11-48 322 R
14.5 Candles
325 L

11-51 337 L
185.0

27380
1950
29430
147.15

11-55 340 R
17 candles

146.5

29 candles
~~8.55~~
~~118.6~~

~~146.6~~ Ohm

25/8

~~2.625~~
~~2.625~~
3.66
4
4
4.25
4.5
4.12
3.5

6.5
5.66
5.5
5.12

4 | 21.78
5.44

7 | 2803
4.

4 : 5.44 :: 9 : 12.24
9
4 | 4896
12.24

0".009 broadside
0".012 Edge

4/13 inches long
shinks 13"/16

1714 grams Wt. of candles

1-51 Lighted

1-5-8 275 R
20 ells 65 R

278 L
25/8 candles

27380
4600
20 | 31980
159.90

4600 Ohms

2— 280 L
280 R
25/8 candles

2-3 295 R
3 3/3 candles

2-5 295 L
4 candles
4300 Ohms
4 candles Broadside

Lamp No. 1135

2-7 5 1/2 candles edge
5 2/3 " "
296 L
5 1/2 candles edge
2-10 297 L.
4 1/8 candles broadside
295 R
4 3.5.0 Ohms
4 1/2 candles broadside
297 R
2-13 300 L
215 300 L
298 R
4580 Ohms
5 1/8 candles Edge
4 1/8 candles Broadside

35.5
9
44.5

1714
1479
235 grains

44.5 : 60 :: 235 : X

2.3717
1.7782
8.3516
2501.5

2 | 317 grains
158.5

240 : 317

317
240
2501.5
23802
1213

1.32 times the candle power read

Add 1/3 to candles read

Lamp No. 1135 .147

2-22 295R
4800 Ohms
5100 Ohms

2-30 299L
3½ candles
Circuit broken and made no change in zero

2-31 345 L
12 + candles

2-35-30 blowed out candles
1479 grains Pt candles
Waiting for operator
Lamp brought up very high

32
24

$\frac{1}{3}$ longer

page 138

9.8 candles at the rate of 8 per H. P.

9.8 : 15 :: 1 : 1.53

11761
9912
0.1849

1.53
21
153
306
3.213

1/2 again as much surface to give 8 per H.P.

12
12
144

12
9
108

12
9
21

12
12
24
21

144 : 108 :: 1 : 5/4

115 Ohms
32
24
154 Ohms

2.1875
2.0334
7.8466
2.0625
11.8851
8.6198
2.1874

page 141

17 candles

27 candles corrected

339.
113

2.0531
2.0531
1.6464
Ohms 147 7.8327
3.5853
27 1.4314
2.1539

142 ft. lbs. per candle

21 24

Lamp No. 1135

After burning at 19 candles for eight hours one side had

1126

280 L

1330 Ohms

5 3/4 candles

287 R

27380
1330
(28710
14355

1140

295 R

1270 Ohms

291 L

7 candles

330 L

300 Ohm

17 Candles

27380
300
2 (27680
13840

1256.
10.95.4
160.6
2
321.2

Lamp. No. 113 B

1256 grams wt candles

1-50.10	Lighted candle
1-53	125 L
	8700
	Light red
1-55	275
	5 candles broadside
	295 W. Ohms
	269 L
	305 L
	1700 Ohms
2 —	307 R
	10.5 candles
	301 L

Lamp 1138

2-3 325 L

0 Ohms

330 R

19.5 Candles

2-10 340 R

Less 6280 Ohms

2600 Ohms

335 L

25 candles broadside

30 candles Edge

2-20 26 " broadside

2-20 Stopped candles.

2-21 5750 Ohms

Lamps No. 1735

2-24 334 L

1337 R

Zero 1 R

20 Cells

65 R

2-27 62.7 L

2-32 5970 Ohms

Candles 109.5 F

2-40 reversed

6600 Ohms

Went with beautiful blue phosphorescence eating away the carbon

Lamp No. 1137

All boxes
+ 8 ~~was~~ Ohms work

280 Ω
7 1/2 candles

7000 + 27380
Burnt with blue phos-
phorescence

Wooden Lamp

160 Ohms

6290
6297
6280
2220

65.½ inches

6290
6297
1220
850
14657
73.2

305 L
310 R

80
65.25
14.75

3.62 5-8
2.37 7-8
1.248

8129
36258
.168 1/2
2.3576

307
102.

2.0086
2.0086
1.6969
73.2 8.1355
3.7991
6300 .4 .5563
.7572
5.7 feet H.P.

17.7
2
35.
17
52

Sodium 3° 58'
Line 2° 15'

The me with the glass
Deflection. 6 ~~[illegible]~~
at 20 candels. and
fourteen at 27 C

6250

83.3	1.9206	
83.3	1.9206	
443	1.6464	5185
Comp 84.4	8.0737	5613
	3.5613	.9572

3640 H. Un. 9.06 per H.P.

12 candle fuse

6.49 Edge

90	1.9542
90	1.9542
	1.6464
62.4	8.0891
	3.6389
4350	.5185
	.8796

7.57 per H.P.

Old regulation
from lamp part slightly black

8 candles + 1/2 12 candle

3 2/3 5.49

250 H.R

2100	3.46
2200	1.55
6290	5.47
6297	
	2100
	2200
	6290
	6297
	16880
	84.4

1700	6290
2200	6297
3900	3900
	16487
	82.43

270 H R

16 candle

17

65 1.8129
1.8129
1.6464
40 8.3978
3.6750
4730 4.8185
.8435

560

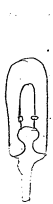
50 to 16 cells
188 ÷ 2

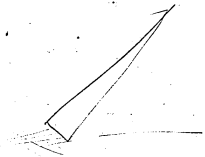
Max 18.80

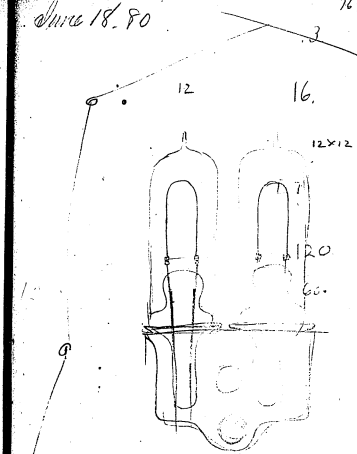
50
16

20 | 65
3.25
4
13.00

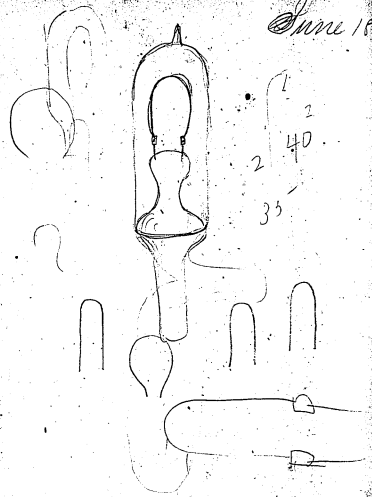
June 18. 80





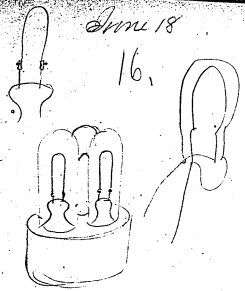


June 18



June 18

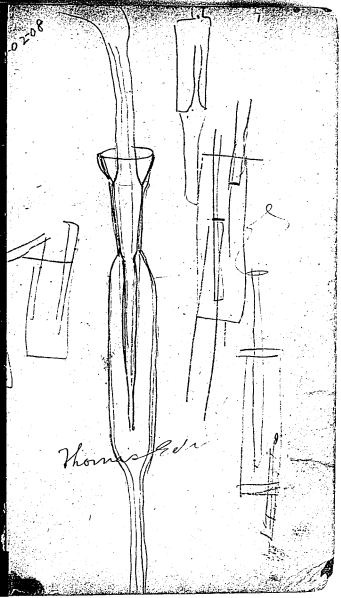
16.



35 50

50 25-0

25


Thomas Bede

Menlo Park Notebook #66 [N-80-02-08.2]

This notebook covers the period March-April 1880. Most of the entries are by Charles L. Clarke. There are also a few entries by Edison and Francis Upton. Included are calculations and tables relating to conductors for the electric lighting system; calculations relating to tests of the system made by Professors Cyrus Fogg Brackett and Charles Augustus Young of Princeton; calculations, drawings, and notes on the shrinkage of carbonized filaments; drawings of pulleys and belts for a dynamo room; and notes on a "Trial of Rotary Engine Engineering Jan. 1, 1875." There are also a series of calculations by Edison about central stations and electric power distribution and a few calculations by Francis Upton about electric power distribution. The name "Clarke" is inscribed on the inside front cover. The inside back cover contains the notation: "Clarke Table of Volts - Ohms - Foot-lbs." There are 284 numbered pages, and the book has been used in both directions.

Filming order: pp. 1-201; pp. 284-202 [in reverse page-number order].

X E172 N-80-02-08.2

Clarke 1

62.39
62.339 68
9182
6

1728) 62.39 (.0361053240 7
5184
10550
10368
1820
1728
9200
8640
5600
5184
4160
3888
2720
2592
1280
1296

252.4956
7728
2096648
1764972
17677972
252495
4362439.968
6232.0567
57
5608
4546
5548

252.79
8.89
227.9966
227

62.39
56.91
5491
4912
4912
0861
5520

100

100 : 97 :: X : .2064

100 : 97 :: 1 : X
.2064

97 : 100 :: .2064 : X
100

97) 20.6400 (.2128
194
270
258
120
97
23

.55
.59
180
180
9

180
97
60
58
2

2064.003824
140
152960
38240
9) 1535360
059948.49

.14

πR²
π(2R)²
π4R²

490
455

2

$\left(\frac{140}{9}\right)^2 =$

140
140
5600
140
.09000
.00001126

117600
39200
17600.

81).0247976009 (.00030488 72/87
243
396
324
7209
648
7200
6945
72

60
72
28
.2064

1.
.0599484 36/81
.0003047 72/81
1.0597787 1/3
2.127835

15.2969945
3.179367
8.917831 2
7.785523
2.119575
1.059787
21.195787.09278
36073.

.2064
.06
12384
2064
.218784

.00215
.00215
.00215

4

97)22550(2
194
3 15
2187

2154
2156
5

75684
153
37052
13920
22764
45684
192 2852

4.5684
6.4
2.5
4.5684
4.5684
274104
2.7.4.5.6.0.2
2.7.4.5.6.0.2

.021159272275)1.000000000000(47.1934687
605779100
1589509000
1193256092.5
409994807.50
211893272.75
198054347.50
190703435.75
7349992750
6356811825
993180925.0
847574870.0
14956060750.0

14.56060150.0
127136236.50
1846997785.00
1692174832.00
1578283000
1483256092.5
35024207.50

47.193469)2255000000000000(.0047782
1887738786
367261240
330354283
36906957.0
33035428.3
3871528.70
3775477.52
96051.180
94386.938
1664242.00
1415804.07
248437.935
235967.345
12469.590

4.7.193469)2255 0000 0000(.004
1887738786

47.193469
2255 7000
235967345
235967345
943386938
943386938
106.42127259.5

1/(1/M) V
.7000
2255.0
2155.0
.03

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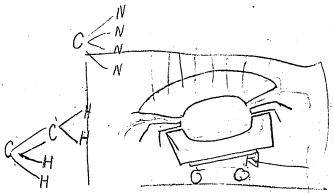
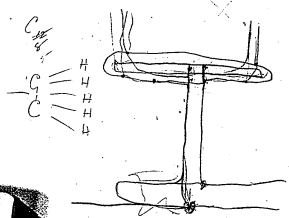
.0000322142857

.0211761) 2189990 (10,33
2111761 ×
713908
635283
786170





7

21.284254519 (4.613486
86) 5 28
516
921) 12 42
921
9223) 32854
28869
92264) 4985557
3692656
922688) 79999590
73812804
5680860

10.6421272595 (3.262225
62) 164
124
646) 4027
3876
6522) 195527
130848
65242) 1483335
1304848
652442) 17844495
13048884
4793110

~~3.262~~

212842545 19
3) 21.284254519 (2.1663
7.094747848 4
46) 309
276
526) 3347
3156
5323) 19184
15969
53266) 3215 54
3199596

9) 21.284254519 0
~~4.258850904038~~
~~3.04460777 88~~
2.369917169

2.6605318 1 (1.6311
26) 166
323) 1760
320) 3631
32621) 37681

8

.5,3210636293 4 (2,3067

43) 132
129
4606) 31063
27636
46127) 342742

4.25685090 3 8 (20632137
4

406) 25685
24336
4123) 132589
12369
41262) 856190
825248
412641) 5666635
4128241
4123423) 15399709
12369269
41264267) 30204310
25111111

3.5473757531 7 0 (1.883448

28) 254
224
365) 3073
2919
3763) 12975
11289
37669) 1686675
1506656
376684) 1801956
1706956
3764888) 2957975 70
3016

9

3,0406077880 (1,74373

27) 204
189
3444) 1506
1376
34887) 13087
10999
348867) 2558788
2440669
3488743) 1180980
1046227

2,1364917169 0 (1,337828

25) 136
125
3.63) 1149
989
3067) 29017
21469
30748) 254816
245984
307562) 8832290
6151124
3075645) 26816660
24604184

2,1284254519 (1,45489

24) 112
96
2855) 16594
14275
29088) 2319325
2326464
29169) 2661435
2625221
29178) 362419

10

3.3166) 4.613486

2.2361) 3.26223 (1.458 89

2 2361 ×

102613

89444

131690

111805

198850

178888

19962 8

17888 8

2073 20

2.4495) 3.26223 (1.331794

2 4495 ×

81273

73485

77880

73485

43950

24495

19455 0

17146 5

2308 50

2199 15

109 350

87 6) 10.642212225 95

~~1.773368187 66~~

~~1.5203038956~~

1.330265907 4

2.6458) 3.26223 (1.232298

2 6458 ×

61643

52916

87270

79374

78960

72916

260440

238122

223180

211

86.11

39.92

12403

46.19

3.62

42.57

41.70

2.84284) 3.26223 (1.153483

2 8284 ×

39.92

1.47

43383

28284

150990

141420

95700

84852

108480

84852

236280

226272

100080

84852

11

44.72

3.62

87.10

12

9) 10.642127259 5-
1.182458584 4

3) 3.26223
1.087 41

3.1623) 3.26223 (1.0316
3 1623 x
99930
94869
50610
31623
189870
15 6 3 3

21.284254 5 19
.00003221 43
63852763557
85137018076
3 1 2 8 4 2 5 4 5 1 9
4 2 5 6 8 5 0 9 0 3 8
4 2 5 6 8 5 0 9 0 3 8
63852763557
.000685657360

10.642127259 5 7
.00003221 43 7
31 9 2 6 3 8 1 7 7 8 5
4 2 5 6 8 5 0 9 0 3 8 0
10 6 4 2 1 2 7 2 5 9 5
3 1 2 8 4 2 5 4 5 1 9 0
3 1 2 8 4 2 5 4 5 1 9 0
3 1 9 2 6 3 8 1 7 7 8 5
.00034 2 8 2 8 6 8 5 5

3) .00 1371314
.000457104

1.0316 × 1.0316 = 1.06421 2725595
1.06421 2725595
1.1 2 0 1 4 0 3 6 7 5 2
4 2 5 6 8 5 0 9 0 3 8
5 3 2 0 1 8 9 7 5
2 5 6 8 5 0 9 0 3 8
4 2 5 6 8 5 0 9 0 3 8
4 2 5 6 8 5 0 9 0 3 8
63852753557
.00068567695438658207 83

13

21,284 2 5 4 5 1 9 0
.00003 2 2 1 4 3
42568509038 0
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21,284 2 5 4 5 1 9
.00003 2 2 1 4 3
63852763557
85137018076
3 1 2 8 4 2 5 4 5 1 9
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63852763557
.000685657360

F.4

14): 0006855657 (41832
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112
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14): 0006855657 (43975
32 XXXX
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16): 1006855657 (42853
42 XXXX
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18) 0006855657 (38092 15
57 XXXX
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99 ! 100 ! ! .2064

~~1.995635~~
8.004365
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8.314708
~~7~~.319073

.20848

~~1.98677~~
8.01323
2.000000
7.314078
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~~1.98677~~ 2559134) 2425-3150 (948
6.01323 2273072
2.00000 1380 1080
7.314709 1143653.6
7.327939 2364 5440

.21278 2559134) 2243 3280 (785
~~1.995635~~ 2001 3938
6.004365 2418 3420
2.000000 2287 3072
7.314709 1320 3480

7.319074 932) 54580 (91
.2084585 920
.2064 932) 7 5520 (842
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14) .0000 6442744 (4.602
56 XXX,00000
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16) .0000 6442744 (402671
6 XXXX
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32
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96
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112
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18) 0000 6442744 (35793
54 XXXX 00000
164
90
172
126
137
126
54
54

Distance	Angle of Mere.	1 Chain Reader					2 Chain Reader				
		Distance	Bearing	Magnet. Bearing Left	Magnet. Bearing Right	Corrd.	Distance	Bearing	Magnet. Bearing Left	Magnet. Bearing Right	Corrd.

100 : 97 :: $\frac{1}{.2064}$

97
2064
2127
97
14889
19143
206519

.2255 ($\frac{1}{.021189372 75}$)

$\frac{D}{M}$

.2064 : .2255 :: 9.718

~~3147097~~
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10.6852903
1.3531465
0.9875769
.02601 37
10.618

7000) .02189 (.0003
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21.284254519
.000003027
14989978163 3
42568509038
638527763557
.00006442743842901 3

3.547375753
7.094751506

21.284254519

7.094751506 (26636

46) 309
276
526) 3347
3156
5323) 19150
15969
53266) 31100
31956

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21.284
.000003027
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42568
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0.80103
0.66903
1.46506
$\bar{5}$.80909
3.20412
$\bar{7}$.01321

0.51357
0.80103
1.31454
~~$\bar{5}$.00799~~
~~3.20412~~
~~$\bar{2}$.28402~~

0.42547
0.80103
1.22650
$\bar{5}$.33203
3.20412
$\bar{2}$.53615

$\bar{5}$.50799
3.20412
$\bar{2}$.71211
0.36299
0.80103
1.16402
$\bar{5}$.20710
3.20412
$\bar{2}$.41122

0.31454
0.80103
1.11557
$\bar{5}$.11025
3.20412
$\bar{2}$.31437

0.27497
0.80103
1.07600
$\bar{5}$.03100
3.20412
$\bar{2}$.23512

0.26748
0.80103
1.01357
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$\bar{2}$.11008

0.16403
0.80103
0.96506
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3.20412
$\bar{2}$.01321

0.12444
0.80103
0.92547
$\bar{6}$.72989
3.20412
$\bar{3}$.93401

22

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0,89199

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3,20412
3,86707

0,06202
0,80103
0,86305

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3,20412
3,80910

0,03639
0,80103
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3,20412
3,76388

0,01351
0,80103
0,81454
6,50799
3,20412
3,71211
1,90309

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0,95155
1,61558
5,80909
3,80618
1,61527

5,20412
5,80909
7,01321
2,505152
5,01030
5,80909
0,81939

10319
64
41276
61914
660416

10319
49
92871
41276
505631

10319
16
61914
10319
165104

10319
36
61914
30957
371484

10319
64
10319
81
103119
825552
83.5839

2,60206
5,20412
5,80909
.01321

10319
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10319
49
92871
41276
505631

10319
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20638
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10319
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92871
41276
505631

2,505-15-00
5,80909
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2,505-15
5,01030
5,80909
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2,30103
4,60206
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0,41115

~~0,80618~~

0,95715-45
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3,80618
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$\bar{1}$,31417

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5,1 12605
$\bar{5}$,80909
0,92169

0,95715-45
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1,37701 5-

3,80618
$\bar{5}$,33203
$\bar{1}$,13821

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5,55630 ~~2.5~~ ,00215 .2064
$\bar{5}$,80909 ,2 .0602
1,36539 ~~26~~ ,1720 ~~4.30~~ ,06620
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2,5772 8 = ,21869.2
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165) 23,1949 (1 8w = 13,13340
165 w = 1,6417
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,36299

3,80618
$\bar{5}$,20710

1,31453 5 $\bar{1}$.01328

0,95715-45
,3145-4

3,80618
$\bar{5}$.11025

1,26608 5 $\bar{2}$,91643

0,95715-45
,27497

3,80618
$\bar{5}$,03100

1,22651 5 $\bar{2}$.83718

0,95715 45
,2248

3,80618
$\bar{6}$,90596

1,16402 5 $\bar{2}$,71214

0,95715 45
,16403

3,80618
$\bar{6}$,80909

1,11557 5 $\bar{2}$,61527

0,95715-45
,12444

3,80618
$\bar{6}$,72989

1,07598 5 $\bar{2}$,53607

0,95715-45
.09096

3,80618
$\bar{5}$,66295

1.04250 5 $\bar{2}$.46913

1772000
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1736740
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2924,5
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10506,20
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8932,00
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12480
8807,80
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7955450
7720,20
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11715
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177,2
531,6
2 | 265,8
443,0

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.06202	8.160498
1.013565	$\bar{2}$.41116
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0.987935	$\bar{2}$.36594
0.951545	3.80618
.01351	8.50799
0.965055	$\bar{2}$.31417
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1.039590 6	4.158362 4
.66403	$\bar{5}$.80909
1.703620 6	$\bar{1}$.967452 4
1.039590 6	4.158362 4
.51357	$\bar{5}$.50799
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1.465060 6	$\bar{1}$.490392 4
1.039590 6	4.158362 4
.36299	$\bar{5}$.20710
1.402580 6	$\bar{1}$.365462 4

1,0395906	4,15836242
31454	7,11025
1,3541306	7,2686124
1,0395906	4,15836 24
27497	3,03100
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21248	8,90596
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16403	8,80909
1,2036206	2,96745 24
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12444	8,72989
1,16403	2,88825 24
1,0395906	4,15836 24
09096	8,66295
1,13055	2,82131 24
1,0395906	4,15836 24
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1,0395906	4,15836 24
03639	8,55976
1,07598	2,71812 24
1,0395906	4,15836 24
01351	8,50799
1,05310	2,66635

2.20417

31

1,10206	4,40824
66403	5,80909
1,76609	0,21733
1,10206	4,40824
51351	5,50799
1,61557	7,91623
1,10206	4,40824
42547	5,33203
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1,10206	4,40824
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1,10206	4,40824
31454	5,11025
1,41660	7,51849
1,10206	4,40824
27497	5,03100
1,37703	7,43924
1,10206	4,40824
21248	6,95596
1,31454	7,31420
1,10206	4,40824
16403	6,80909
1,26609	7,21733
1,10206	4,40824
12444	6,72989
1,22650	7,13813

30

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1,19302	170	7,07119
	68	
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1,10206		4,40824
03639		5,55476
1,13845		2,96800
1,10206		4,40824
01351		5,50799
1,11557		2,91623
2/2,30103		
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66403		5,80909
1,81454		0,41115
1,150515		4,60206
51351		5,50799
1,66402		0,11005
1,150515		4,60206
42547		5,33203
1,57598		7,93409
1,150515		4,60206
36299		5,20710
1,513505		7,80916

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	35	T.71231
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27497	25	T.031 00
1.42548 5	425	T.633 06
		4.60206
1.25057 5		T.70596
2248		
0.21248		T.90596
1.362895		T.56852
0.16403		T.72854
1.37454		T.33185
		4.66716
0.12444		T.52889
1.27495		T.3319
0.08096		T.62275
1.27147		T.26501
06202		T.60498
1.21253		T.26704
03639		T.55976
1.186905		T.16182
01351		T.50799
1.164025		T.11005
56403		T.50909
1.85413		0.58995124
51351		T.50799
1.70361		0.26841
42547		T.33303
1.61557		0.09245

35

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0.91428 5	0.0	0.0
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06202
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720
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.00842
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3,5280
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12
5,11025
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6,72989
7,49031

4,60206
6,80909
7,41115

36
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7,66295
7,92337

7,60498
7,36540

7,58976
7,34018

1,60206
3,20412
5,15976
3,76388

31.416 : 20 : : 10 : 3.1416

31,416 / 200,000 (6.36

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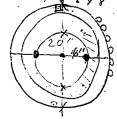

20,920 6283.

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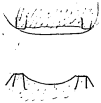
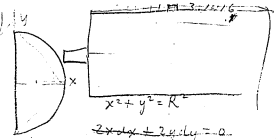
208





$x^2 + y^2 = R^2$

$\cancel{2xdx + 2ydy = 0.}$

$y = \sqrt{R^2 - x^2}$

$$X_1 = \frac{\int x\sqrt{R^2-x^2}\,dx}{\int \sqrt{R^2-x^2}\,dx}$$

3.1416

60 / 314160

53

3142
2142
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12568
31420
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9872164

32 / 9872164 / 30 322 / 9872164 / 493.6082

56 x x
272

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2809
16 / 14057 / 125.68
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1.25

2,505715

0,03639	$\bar{1}$,55976
1,25996	$\bar{1}$,45407
0,01351	$\bar{1}$,50799
1,23708	$\bar{1}$,40230
0,66403	$\bar{1}$,80909
1,91660	0,81939
0,51351	$\bar{1}$,50799
1,76608	0,51829
0,42547	$\bar{1}$,33203
1,67804	0,34233
0,36249	$\bar{1}$,20710
1,61556	0,2174
0,31454	$\bar{1}$,11025
1,56711	0,12055
0,27497	$\bar{1}$,03100
1,52754	0,0413
0,21248	$\bar{1}$,90596
1,46505	$\bar{1}$,91626
0,16403	$\bar{1}$,80909
1,41660	$\bar{1}$,81939
2,38021	
4,78042	
1,80909	
$\bar{1}$,59951	

12444	$\bar{6},72989$
1,37701	1,74019
09096	$\bar{6},66295$
1,34355	1,67325
,06202	$\bar{6},60498$
1,31459	1,61528
03639	$\bar{5},55976$
1,25886	0,5700
01351	$\bar{6},50799$
1,26608	1,51828

,020943	
,021166	,000228
,021394	
,021629	,062235
66402	$\bar{5},80909$
1,94218125	0,921695
51351	$\bar{3},50799$
1,79166	0,62059
42547	$\bar{3},33203$
1,70362	0,044635
36299	$\bar{3},20710$
1,64114	0,319705
31457	$\bar{3},11025$
1,59269	0,22285

27487
1,553 12

21248
1,49063/25

16403
1,44218

12444
1,40259

.09096
1.36911

.06202
1,34017

.03639
1,31454

.01351
1,29166

.06403
1,96506

$\bar{5}$,50799
1,06429

$\bar{5}$,33203
0,88833

$\bar{5}$,20710
0,76340

$\bar{5}$,11020
0,66655

81
243
81
243
81
1653
$\bar{5}$,03100
0,74360 5
1377

$\bar{5}$,90596
0,01856 65

$\bar{6}$,80909
7,92169

$\bar{6}$,72989
7,84249 5

$\bar{6}$,66298
7,77555

$\bar{6}$,60498
7,71758

10,309
25
51545
206 15
257 = 25

$\bar{5}$,55976
7,67236

$\bar{5}$,50799
7,62059 5

$\bar{5}$,80909
1,01321

5,1949
2,577

When

$\bar{5}$,03100
0,98730

$\bar{5}$,90596
0,92276

$\bar{6}$,80909
0,36539

$\bar{6}$,72989
0,28679

r = Resistance at 0°C, or 32°F.

t = temperature Fahrenheit.

$$R = r\left[1 + a\tfrac{5}{9}(t-32) \pm b\left(\tfrac{5}{9}\right)^2(t-32)^2\right].$$

For Copper $a = .003824$ $b = +.00000126$

Then formula is

$$R = r\left[1 + .002124(t-32) + .0000003889(t-32)^2\right].$$

Take as ex 10°C. = 50°F.

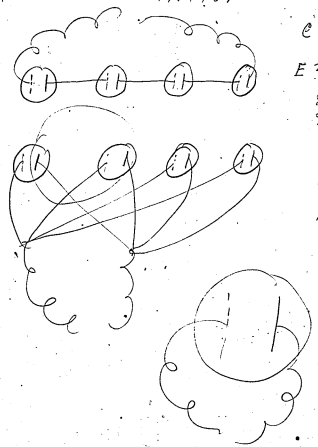
$$R = .2654\left(1 + .003824(10) + .0000012\ldots\right)$$

$$R = .2654\left(1 + .002124\ldots + .0000003889(18)^2\right)$$

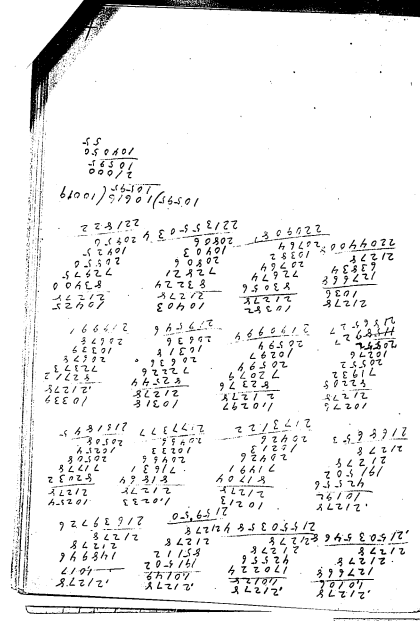
	06202	$\bar{6}.60498$
	1.36305	7.80910
	03639	$\bar{6}.55976$
	1.33742	7.76388
	01351	$\bar{6}.50799$
	1.31454	7.71211
	66403	$\bar{5}.80909$
	1.985756	1.09
	51351	$\bar{5}.50799$
	1.835236	0.79689
	42547	$\bar{5}.33203$
	1.747196	0.61893
	36299	$\bar{5}.20710$
	1.688716	0.49400
	31454	$\bar{5}.11025$
	1.636266	0.39715
	27497	$\bar{5}.03100$
	1.59669	0.31790
	21248	$\bar{6}.90596$
	1.534206	0.19286
	16403	$\bar{6}.80909$
	1.485756	0.09599
	72444	$\bar{6}.72989$
	1.446166	0.01679
	09096	$\bar{6}.66295$
	1.412816	1.94985
	06202	$\bar{6}.60498$
	1.383746	1.89188

03639
1,358116
01351
1,335236

8,55976
7,84666
8,50799
7,79489



66403	$\bar{3}$, 80909
2,00465	1,17157
51351	$\bar{3}$, 50799
1,85913	0,87047
42547	$\bar{3}$, 33203
1,76609	0,69451
36299	$\bar{3}$, 20710
1,70361	0,56958
31454	$\bar{3}$, 11025
1,65516	0,47273
27497	$\bar{3}$, 03200
1,61519	0,39345
21248	$\bar{3}$, 90596
1,55310	0,26844
16403	$\bar{3}$, 80909
1,50465	0,17157
12444	$\bar{3}$, 72988
1,46506	0,09237
09086	$\bar{3}$, 66295
1,43158	0,02543
06202	$\bar{3}$, 60498
1,40264	$\bar{3}$, 96746
03639	$\bar{3}$, 55996
1,37701	$\bar{3}$, 92224
01351	$\bar{3}$, 50799
1,35413	$\bar{3}$, 87047



66403	$\bar{3},80909$
2,02203	1,24109
51354	$\bar{3},50799$
1,87151	0,93999
42547	$\bar{3},33203$
1,78347	0,76403
36299	$\bar{3},20710$
1,72099	0,63710
31454	$\bar{3},11025$
1,67254	0,54225
27497	$\bar{3},03100$
1,63297	0,45300
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16403	$\bar{3},80909$
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12444	$\bar{3},72989$
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42547	$\bar{3}.33203$
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09096	$\bar{3}.66293$
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a-3 3-2 2-1

a -2b +c

b-2c+d

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16.636
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5.808
23.232
6.736
26.944
7.733
30.932

3.298
13.192
4.174
16.696
5.154
20.616
6.236
24.944
7.421
29.684
8.710
34.840
10.101
40.404
11.596
46.384

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5.500
2.088
8.352
2.575
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3.712
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4.356
17.424
5.052
20.208
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23.200

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5.898000

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14.845
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23.195
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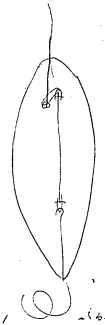
3 6 6 3 0
3 1 3 0 5 0



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2,062	1,718	1,289
8,248	6,872	5,156
2,496	2,079	1,559
9,984	8,316	6,236
2,970	2,475	1,855
11,880	9,900	7,420
3,484	2,904	2,178
13,936	11,616	8,712
4,042	3,368	2,525
16,168	13,472	10,100
4,640	3,866	2,899
18,560	15,464	11,596
,660	,550	,471
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,835	,696	,596
3,340	2,784	2,384
1,039	,859	,736
4,156	3,436	2,944
1,247	1,039	1,891
4,988	4,156	3,564
1,485	1,237	1,060
5,940	4,948	4,240
1,742	1,452	1,244
6,968	5,808	4,976
2,021	1,684	1,443
8,084	6,736	5,772
2,320	1,933	1,657
9,280	7,732	6,628

$R \propto \frac{L}{m}$

$R = 10.642 \frac{L}{m}$.

$m = \frac{10.642 L}{R}$

$L = 2.0 \mu$

$R = 2.0 \text{ ohm}$

$m = \frac{10.642 \times 2.0}{2}$

$m = 10.642 \text{ ohm}$

4436

10/10.642

10.6642
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63852
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1287/1220
1287/9678
13677/3569
13748/7112

.06878

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7,3	2,2	2,25	
7,3	31771	9,59	
40,74	3,4	9	
1,59	2,4		
3,85	3,9		
1,59	2,4		
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66403
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36299
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31457
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8	143648
9	161604
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12	215472
13	233428
14	257384
15	273340
16	292296
17	305252
18	323208
19	341164
20	358120
21	377076
22	395032
23	412988
24	430944

66403	2.12617	3.80909
51351	1.92652	1.57692
42547	1.88267	3.50799
36299	1.82513	1.26962
31454	1.77468	3.33203
27497	1.73711	1.03366
21248	1.67462	3.20710
16423	1.62647	0.95873
12444	1.58658	3.11025
08096	1.53310	0.87188
06202	1.52476	3.03100
03639	1.49853	0.77263
01351	1.47565	3.70596
		0.66759
		3.80904
		0.57072
		3.72989
		0.49752
		3.66295
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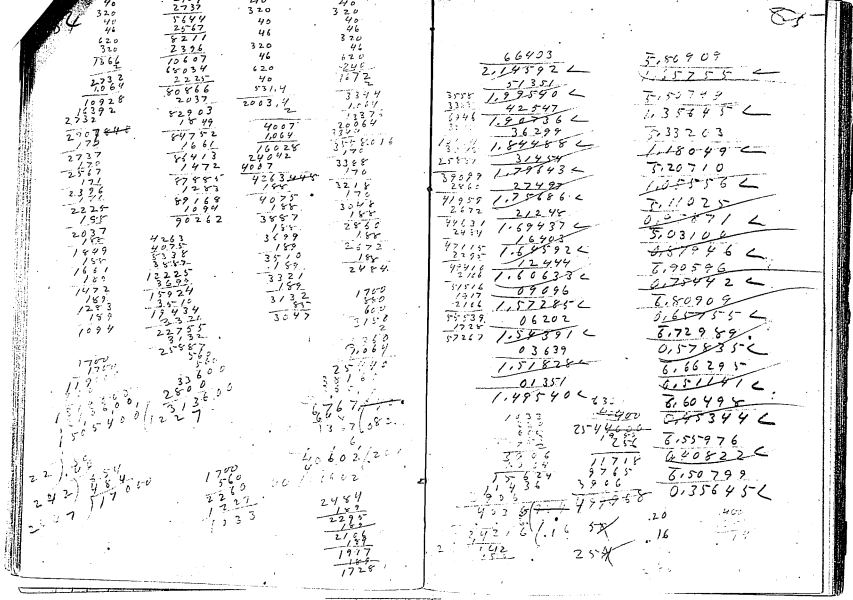

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66403
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$r : R :: Z : I$

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$r : R :: \frac{1}{c} : \frac{1}{C}$

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$R : C :: r : c$

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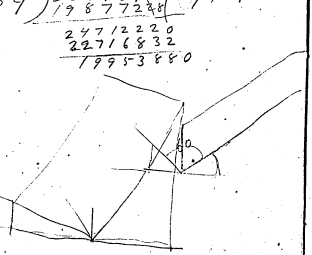

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3.5
5

1.4914 ~~117~~
2.3026
89484
29828
14742
9828
1131497 64

8388.5
2.3026
503310
167770
25165 5
167770
19315360 10

17.3
5 | 15.5 3/10
31 3/10
2.2
3
6

18.6
5 | 17.2 1/2
32 1/2
32
64

2.13
1.8 9/5
100

14.2
5 | 132 3/10
26 2/10
3.5
12.8

1.5
3.5
5
14

5 | 114 3/10
22 4/10
3.2
5.4

15.5
5 | 139.8
27 1/2
32
139

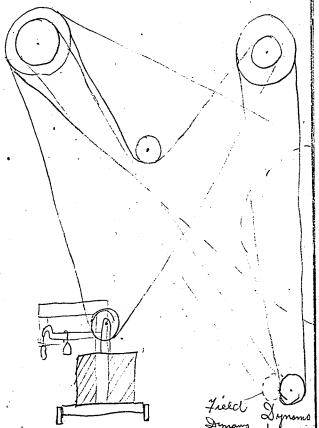
7
3.9
5

5 | 136 1/2
23 1/2
3.7
5

5 | 18.8 1/5
3.8
5.8

129

April 15th 1888.
Sketch of pulleys and belts in dynamo room.



130

201.06
60
12063.60
73
36190.8
10063.6
15582.06
77
1977876
1977876
12075.636

196.15
60
11769.0
3
35307
1789
15297
77
122397.6

D .111 = 10.642L / R = .1646

1.0642
1600
63.852
1.0642
60.
63.8520

1915.56
1854.704
3767.260
7453.856
555.129
7539.000
7278.128
7660.152
5939.280
15962.3
15355.580
15332.944
12068.028
16685.556
15536.624
19041.744
14944.368
13960.892
16252.260
9277.040
17559.320
14731.988
18772.988
14942.336
19921.824

1149.336
63.852
1085.484
63.852
1021.632
63.852
957.780
63.852
893.928
63.852
830.076
63.852
766.224
63.852
702.372
63.852
638.520
63.852
574.668
63.852
510.816
63.852
446.964
63.852
383.112
63.852
319.260
63.852
255.408
63.852
191.556
63.852
127.704
63.852
63.852

19921.824
1085.484
18836.340
18836.340
22328.190
957.780
22386.720
893.928
23480.648
830.076
24710.724
766.224
25476.948
702.372
26179.320
638.520
26817.840
574.668
27392.508
510.816
27903.324
446.964
28350.288
383.112
28733.400
319.260
29052.660
255.408
29307.068
191.556
29498.624
127.704
30127.328
63.852
30191.180

3832 = 10.642×60
R

R = 10.642
60.
3832) 638.520 (.166
3832
2558
2298
2540
332

$R = \frac{10,642\,L}{m}$

30191.18
60352.36

10.642
120
2132.840
10.642
1277.04 × 2
2554.08

1277.04	log	3. 1061909	
1277.04		4. 7505255	
		5. 3252838	.021149
2554.08	log	3. 4072209	
1277.04		4. 7798859	
3831.12	log	3. 5583235	
1277.04		4. 7585713	
5108.16	log	3. 7082679	
1277.04		4. 7753628	
6385.20	log	3. 8051745	
1277.04		4. 7716316	
7662.24	log	3. 8843535	
1277.04		4. 7667034	
8939.28	log	3. 9513035	
1277.04		4. 7535831	
10216.32	log	4. 0092964	
1277.04		4. 7466809	
11493.36	log	4. 0604334	
1277.04		4. 7386696	
12770.40	log	4. 1061909	
1277.04		4. 7294564	
14047.44	log	4. 1475836	
1277.04		4. 7189530	
15324.48	log	4. 1853721	
1277.04		4. 7071783	
16601.52	log	4. 2201604	
1277.04		4. 6932203	
17878.56	log	4. 2523432	
1277.04		4. 6790875	

19155.60 log 4. 282 2 3 048
1277.04 4. 662 5 1 2 3

20432.64 log 4. 310 3 3 2 1
1277.04 4. 644 0 2 4 8

21709.68 log 4. 336 6 5 9 8
1277.04 4. 623 3 9 4 0

22986.72 log 4. 361 4 5 2 3
1277.04 4. 600 3 6 2 9

24263.76 log 4. 384 9 6 2 4
1277.04 4. 574 5 4 0 5

25540.80 log 4. 4072379
1277.04 4. 545 5 2 9 8

26817.84 log 4. 4284264
1277.04 4. 512 7 3 7 7

28094.88 log 4. 4486290
1277.04 4. 475 4 0 9 7

29371.92 log 4. 4679335
1277.04 4. 432 5 5 2 4

30648.96 log 4. 4564163
1277.04 4. 382 6 6 5 3

31926.00 log 4. 5041445
1277.04 4. 3237058

33203.04 log 4. 5211773
1277.04 4. 252 3 1 5 9

34480.08 log 4. 5375673
1277.04 4. 113 1 0 1 7

0215
0216
.6431
.0216
.0647
.0215
.6865
.0220
.7085
.0222
.7307
.0225
.7532
.0229
.7761
.0233
.7994
.0237
.8231
.0242
.8473
.0247
.8720
.0251
.8971
.0257
.9228
.0262
.9490

35757.12 log 4. 553 3 6 2 1
1277.04 4. 095 5 7 1 4

37034.16 log 4. 5686006
1277.04 3. 5770256

38311.20 log 4. 5833235
1277.04 3. 5834255

465) 19.5555 (.0218
3905
850
2350
2340
2340

464) 10.0000 (.215
928
720
560
3520
3240
2400

461) 19.5555 (.0216
3910
760
4.12
2950
2772
1.78

459) 10.0000 (.217
918
820
1020
3410
3213
197

455) 10.0000 (.220
9100
900
10.00
9100
900

458) 10.0000 (.222
916
1000
1000

444) 10.0000 (.225
888
1120
888
2320

437) 10.0000 (.229
874
1260
1048
2120
1748
3850
3496

429) 10.0000 (.233
858
1420
1287
1330

420) 10.0000 (.238
840
1600
1428
3490
3360
130

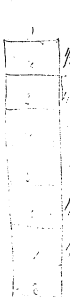
418) 10.0000 (.244
836
180
164
160

398) 10.0000 (.251
796
2020
1990
2250

387) 10.0000 (.258
774
2260
2064
1960
1935
2550
2322
2280
154

374) 10.0000 (.267
748
2520
2244
2760
2618
142

136



$1/10 = R'$

$1/9 = R''$ $\frac{1}{19}$

$\frac{1}{27}$

$\frac{1}{35}$

$\frac{1}{40}$

$\frac{1}{45}$

$\frac{10}{465}$

465)10.0000(.021510
930
700
465
2350
1395
955

13)

$$\frac{1}{R} = \frac{1}{R'} + \frac{1}{R''}$$

$$R = \frac{R'R''}{R' + R''}$$

$$R = \frac{\frac{1}{10} \times \frac{1}{9}}{\frac{1}{10} + \frac{1}{9}} = \frac{1}{19}$$

465
93
465
465
462
3
455
9
455
5
450
5
445
7
437
8
429
9
420
10
410
3577
14
387
23
377
14
360
15
345
16
329

329
12
312
28
284
19
275
20
255
21
234
22
212
23
189
24
165
25
140
26
114
27
87
28
59
29
30

1.32552 / .02257
.3530
.0290
.3820
.0364
.4124
.03321
.44445
.0340
.47785
.0364
.51149
.03392
.5541
.0427
.59665
.0471
.64139
.0329
.6768
.0606
.7574
.0714
.8288
.0877
.9165
.1149
1.0314
.1685
1.2000
.3333
1.5342

314) 10.0000 (.278
2357
250
252
280
258

345) 10.0000 (.289
690×
3100
2760
3400
3105
295

329) 10.0000 (.304
587×
1300
1172

312) 10.0000 (.3205
936×
640
624
1600

294) 10.0000 (.340
825×
1750
1176
40

275) 10.0000 (.365
825×
1750
1650
1000
1122

255) 10.0000 (.392
765×
2350
2295
550
715

234) 10.0000 (.427
936×
640
468
1720
1638

212) 10.0000 (.471
848
1520
1696
360

189) 10.0000 (.529
945×
550
378
1720
1701

165) 10.0000 (.606
990×
1000
990

144) 10.0000 (.714
756×
2600
2520
80

114) 10.0000 (.877
913×
3700
3195
820
795
25
22

87) 10.0000 (.1149
87×
130
87
430
348
820
783
37

59) 10.0000 (.1695
59×
410
354
560
531
290
295
5

30) 10.0000 (.33377
90
100

$\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{5}$

$100\frac{10}{30}$, 100, $\frac{10}{39}$

$\frac{3000}{30}$, $\frac{3000}{30}$, $\frac{10}{39}$

$\frac{20}{3010} + \frac{1}{100} + \frac{50}{10}$

3000
300
301
3010.1775500
301.1775500
17811.91
30100) 178191 (
3010
3775
3010
7650
6020
1630
1505
125
30100) 30100 (
50
601

$100\frac{10}{30} = \frac{3010}{30}$, 100 ∴ $\frac{20}{3010} + \frac{1}{100} = \frac{300}{30100} = \frac{301}{30100}$

Conv. = $\frac{601}{30100}$, R = 601) 30100 (50.1
50

601) 50.0000 (.08332
4808
1920
1803
1170
502527, 100 ∴ $\frac{10000}{502527} + \frac{1}{100} = \frac{1000000 + 502527}{50252700}$

50.0000
2527

1000000
502527
15.02527) 50.0000 (32.44555
.1149
.5264
5025270
5777890
4525270
6693000
6021810
6829820
6010105
5171520
7512635
6544850

140 $\frac{335604}{10000}$ :: $\frac{10000}{335604} + \frac{1}{100} = \frac{1000000 + 33560400}{33560400}$

33560400

13335604) 33560400 (25.12755
26712416 x 0577
6848520 2752
6478020
17030800
13331604
3699196
2671205
1027991 20
7399225
6782920

$25\frac{3152}{10000}$ :: $\frac{10000}{25321152} + \frac{1}{100} = \frac{1000000 + 2532115200}{2532115200}$

12521152) 25321152 00 (20.1375
25042304 x 0714
1721600
12521152 20,2089
4697448
3256952
9380240
8765064
615176 20
5010468
1043752

$20\frac{2089}{10000}$ :: $\frac{10000}{202089} + \frac{1}{100} = \frac{1000000 + 20208900}{20208900}$

1202089) 20208900 (16.8115
12020890 x 0602
8185010
7212534
9728476
9618712
3969620
1386960
1202089
1783910
1202089
581821 20
500835 20
100985 4

$\frac{10000}{15721} + \frac{1}{100} = \frac{1000000 + 1572100}{1572100}$

1168721) 16572100 (14.1364
11685721 x 0524
4886380
4674884
2110960
1007884
9251760
3506163
7455970
7012326
4431640
3506163
9362700

$\frac{10000}{14,4893} + \frac{1}{100} = \frac{1000000 + 1448930}{1448930}$

1144893) 14489300 (12.6556
11448931 x 0471 7027
3040369
2290786
7505840
6293358
6364820
5724465
6403550
5724465
6790850
6124465
6663850
5724465
9391850
8015930
1376000

$\frac{10000}{127027} + \frac{1}{100} = \frac{1000000 + 12702700}{12702700}$

1127027) 12702700 (11.2740
11270271 x 0427 3137
1432430
1127027
3054030
2254054
7990760
7887189
1103710 00
1014324 3
9138570

1X

$$\frac{10000}{113137} + \frac{1}{100} = \frac{1000000 + 113137}{11313700}$$

```
1113137) 11313700 (10.1638
         11131370
          1823300     0392
          1113137     2030
           7101630
           6678822
           4228080
           3339411
            8886690
```

$$\frac{10000}{102030} + \frac{1}{100} = \frac{1000000 + 102030}{10203000}$$

```
1102030) 10203000 (9.2548
         9918270     0364
          2847300
          2204060     2948
           6432400
           5510100
            9222300
            8816240
             4062600
             3306080
              756520
```

$$\frac{10000}{92948} + \frac{1}{100} = \frac{1000000 + 9.2948}{9294800}$$

```
1092948) 9294800 (8.5043
         8739584     0340
          5512160
          5464740
           4742000
           4371792
            3702080
            3278844
             4232360
```

8.5043
.0340
8.5383

$$\frac{10000}{85364} + \frac{1}{100} = \frac{1000000 + 85364}{8536400}$$

1X

```
1055304) 8536400 (7.8650
         7597544
          9388520
          9527120
           7956080
           6327584
           5639960
           5268220
            1214000
```

$$\frac{10000}{85383} + \frac{1}{100} = \frac{1000000 + 85383}{8538300}$$

```
1085383) 8538300 (7.8668
         7597651     3321
          9406190
          9530647 8987
          7231760
          6512298
           7189620
           6512985
           6773220
           6512220
            682200
```

$$\frac{10000}{78987} + \frac{1}{100} = \frac{1000000 + 78987}{7898700}$$

```
1078987) 7898700 (7.3205
         7552908     0304
          3457919
          3236961     3509
           2209970
           2157904
            5191600
            3775948
             1415520
```

14

428.8 — 48°$\frac{1}{5}$ — mercury, and vion.

428. — 54°$\frac{43}{50}$ — Water.

427.7 — 57°$\frac{1}{5}$ — Water.

427.5 — 58°$\frac{1}{10}$ — Water.

427.6 — 59°$\frac{23}{50}$ — Water.

427.4 — 59° — Water.

426. — 59°$\frac{1}{2}$ — Water.

426.3 — 63°$\frac{7}{50}$ — Water.

426.7 — 65°$\frac{12}{25}$ — Water.

Remark upon the first test by Profs. Brackett and Young

15

$\frac{10000}{73509} + \frac{1}{100} = \frac{1000000}{73509} + 73509$

73509.50

10735 09) 73509000 (6.84975
64410354
9098646 0
6588072 0
5710388 0
9294036
8098440
7574563
5838770
5367535
4722250

$\frac{10000}{68764} + \frac{1}{100} = \frac{1000000}{68764} + 68764$

58764.00

10687 64) 6876400 (6.4340
6412584
4638160
4275056
3631040
3206292
4247480
3206292
1041188 0
961887 6
7930040

$\frac{10000}{64618} + \frac{1}{100} = \frac{1000000}{64618} + 64618$

64618.00

10646 18) 6461800 (6.0696
6387708
7409200
6387708
1021592 0
9581562
6343580

146

	27.	1.4314
	27.	1.4314
	44.3	1.6464
dmp	2.22	9.6538
	144	4.1628
	33000	4.5185
		.6443

44.1

~~144~~

	40	1.6021
1.44	1.44	0.1584
.74		1.4437
2.18	40	1.6021
	2.18	0.3385
	18.4	1.2636

14

70.400)	4.8476
2.18	0.3385
32300	4.5091

24.7	1.3927
24.7	1.3927
1.44	0.1584
44.3	1.6464
	4.5902
	4.5185
	.0717

1.17

1.44
.74
.70

44.3
44.28

.7 ~~70.4000~~
106571

1.44
.74

48000
24000
14000
34000

86.1 1.9350
86.1 1.9350
Comp 1.345 9.8715
443 1.6464
244.000 5.3879
7.41 4.5185
.8694

84.4 1.9263
84.4 1.9263
comp 2.62 9.5817
44.3 1.6464
5.0807
4.5185
3.65 .56.22

44.3
60

.21
.28

5.77 : 5.51 :: 7.7

7.7	0.8865
5.51	0.7412
5.77	9.2388
	.8665

7.35

2.106
2.81

2.81
33000

2.51
33000
843
843
9.27 30.00 .21
92

.28
.32
84
84
9.240.00 (44
84
.84

44000 ft. lbs.

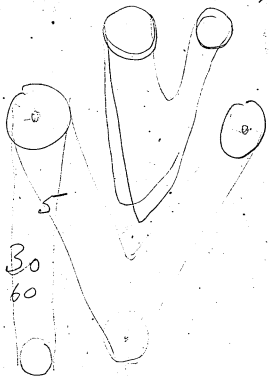
5.51
44 000
2204000
2204
242.4 ~~40000~~ | 7.34
33000
241
1144
99
154

7.34 H.P.

1/4 Ohm

33000

12
144
44
576
576
6336



15 × √(6.1007 − 4.55539 / 396944) + .00001184

6.1007
4.55539 .000000

396944) 1.54668200000 (3.89
1190832
35585850
31755552
3829298
3572496
2687840
2387664
2061760

.00006359
.00001184
.00007543) 3.68 (.003967

69) 673
621
786) 5265
4716
7877) 5530
5313

.003967
0.03441
.005526) 1.000000 (1901.14
5526
4748
4737
600
526
740
526
2140
1852
2800

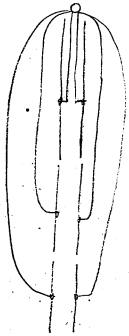
1750 feet Entrance from the central Station.

2,30255
1.97772236
69077255
46051700
16118095
16118095
16118095
20723265
23025585
453872

Statement No 1

39694

59673
59725
48



156

1750 feet Each way from station.

300 Lamps 100 ohms Each

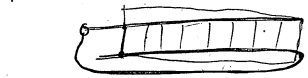
1750 feet each way from Station.

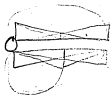
Statement No 2

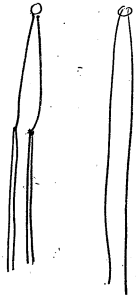
300 Lamps. 100 ohm

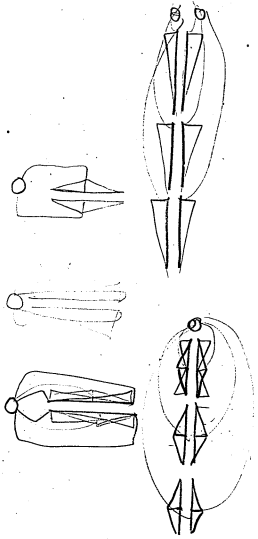
R – 100 on section.

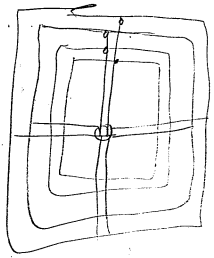
6 sections also.











162) 443000.0000 (12339.5

3.5902

3.5902) 100.00000 (27.85

27.85
44.3
8355
11140
11140
1233.755
1.2.55
1110379 5
9570040
24675 10
12337 55
1536.1015

$$\frac{44.3 \times E^2}{R} = W$$

$$\frac{E}{R} = \frac{W}{44.3\,E}$$

$$C = \frac{W}{44.3\,E}$$

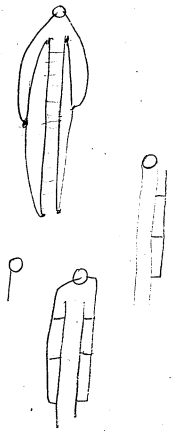
$$W = 44.3\,E\,C$$

3.5902
3.5902
71804
32315
39510
10770 6
125839 3 6 0 4

$\therefore \frac{E}{R} = C$

27.85
27.85
13925
22280
19495
5570
775.6 225

$\therefore$ 775.6 :: 443000



164 Trial of Rotary Engine,
Engineering Jan. 1, 1875.

Every five minutes record was taken of following quantities.

Pressure of Steam by Gauge.
Pressure of Exhaust by Gauge.
Revolutions of Engine by Speed Indicator.
Reading of Brake Scale in lbs.
Temp. of Injection Water } Exhaust-
Temp. of Discharge Water } Steam Tank.

Exhaust-Steam Tank, of iron 4 ft diam. 6 ft. high, Pipe at bottom formed into a cross and perforated with small holes the aggregate area of which was greater than that of pipe.

Steam gauge was attached to steam pipe just within the throttle and also steam and vacuum gauges on the exhaust.

Water in tank was kept at constant height of 70 inches.

Loss by radiation and evaporation in tank was found by heating the water in it to a certain temp.

165 and the rate of loss ascertained. (I would find it by allowing water at constant temperature to flow through. The proper mode during the experiment, if there be abundance of water, would be to allow water to pass in such a quantity that the temperature in outflow would be as much above the atmosphere as the inflow is below the atmosphere).

The rate of flow must be known. Temp. of air should also be observed.

P=

$\frac{10000}{60963} + \frac{1}{100} = \frac{1000000 + 609.63}{6096300.}$

106096.3) 6096300 (57.460
32.48155
7914855.0
7426741 57718
4881090
1243852
63723.80
6367.78
60200

$\frac{10000}{57718} + \frac{1}{100} = \frac{1000000 + 577.18}{5771800}$

105771.8) 5771800 (54.5468
5285590
4832100
4230872
601228.0
528559.0
72369.00
63463.08
8905920
7461744
1441760

$\frac{10000}{54819} + \frac{1}{100} = \frac{1000000 + 548.19}{5481900}$

1054819) 5481900 (5.1970
5274095
207805.0
105481.9
102323.10
94833.71
7489390
7383733
565700

$\frac{10000}{52214} + \frac{1}{100} = \frac{1000000 + 522.14}{5221400}$

105221.4) 5221400 (4.96223
4208856
1012544.0 4.9861
846926
655570
631354
24160.60
21069.28
3141320

$\frac{10000}{49861} + \frac{1}{100} = \frac{1000000 + 498.61}{4986100}$

1049861) 4986100 (4.7493
4198444
787656.0
739027
51755.30
41994.44
9761.60
8398.79
1362.10

$\frac{10000}{47726} + \frac{1}{100} = \frac{1000000 + 477.26}{4772600}$

1047726) 4772600 (4.55552
4190904
582696.0
523863.0 4.5781
57833.00
52386.30
5446.700
5238.630
2108.700

$$\frac{10000}{45781} + \frac{1}{100} = \frac{1000000 + 45781}{4578100}$$

```
10 45781) 4578100 (4.3777
          4583124
           39499760
           31373343
            8126417 0
            7320467
             5037030
             7320467
              7165630
              6546540
               619090
```

$$\frac{10000}{44002} + \frac{1}{100} = \frac{1000000 + 44002}{4400200}$$

```
10 44002) 4400200 (4.2147
          4176008
           224192 0
           2850092 (4.2359
           1533916
           1047028
            4951580
            4176005
             775720
             330614
              44906
```

$$\frac{10000}{42369} + \frac{1}{100} = \frac{1000000 + 42369}{4236900}$$

```
10 42369) 4236900 (4.0647
          4167716
           67420 0 0
           6354214 (4.0867
           4881860
           1165476
           1123840
```


$$\frac{10000}{40867} + \frac{1}{100} = \frac{1000000 + 40867}{4086700}$$

```
10 40867) 4086700 (3.9262
          3122601
           964099 0 (3.9480
           936780 3
            27319 7 0
            20817 3 4
             6501360
             6245202
              2561580
              2081734
               479846 0
```

$$\frac{10000}{39480} + \frac{1}{100} = \frac{1000000 + 39480}{3948000}$$

```
10 39480) 3948000 (3.7981
          3158400
           7896000
           7276360
            1019400
            1035320
             83708 0
             83158 0
              5496000
```

$$\frac{10000}{38197} + \frac{1}{100} = \frac{1000000 + 38197}{3819700}$$

```
10 38197) 3819700 (3.6797
          3114391
           705309 0
           622918 2
            82190 8 0
            72673 7 8
             9517 0 1 0
             6365 7 6
              1151 4 3 4
              9343 7 7 3
               1732 3 7 0
               1038 1 9 7
```

170

$$\frac{10000}{37008} + \frac{1}{100} = \frac{1000000 + 37008}{3700800}$$

10 37008) 3700 5000 (3.15687
3 111 0 24
0 2 15
5 5 9 7 7 6 0 0
5 1 5 5 0 4 0 3, 5 9 0 2
7 1 2 2 2 0 0
6 3 2 2 0 4 4
9 0 5 7 1 5 2 0
5 2 7 6 0 6 4
7 5 5 4 1 5 6 0
7 2 5 9 0 5 6
2 9 5 5 0 4 0

3.7008) 359.0200 (97.0114
333 0 72 X
2 5 9 4 8 0
~~2 7 3 0 4 4~~
~~3 2 4 3 2 0~~
2 5 9 0 5 6
6 2 4 0 0 0
3 7 0 0 8
5 3 9 2 0
3 7 0 0 8
1 6 9 1 2 0
1 4 8 0 3 2
1 0 8 8 8

3.85197) 359.0200 (96.7
3 4 5 7 6 X
~~5 3 4 4 4 0~~
~~3 3 5 0 7 2~~
2 5 8 1 8 0
~~2 5 9 1 8 2~~
~~2 0 6 7 8 0~~
~~1 0 5 3 8 0~~
~~1 7 4 4 4~~

171

a , b , c , d
x y z , t

$z : a :: x : y$

$y = \frac{ax}{z}$

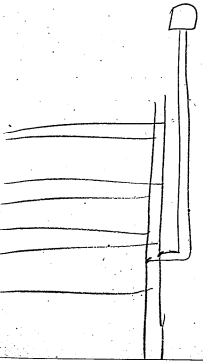
$c : z :: y : z$

$z = \frac{zy}{c} = \frac{axy}{zc}$

$d : c :: z : t$

$t = \frac{cz}{d}$

$t = \frac{axy}{zd}$



172

3.8197) 359.0200 (93.9917
343773×
152470
147391
378790
343773
350170
343773
63970
38197
25773
23739

3.9480) 359.0200 (90.9372
~~355.3200×~~
~~43.1800~~
355320
370000
355320
14680
11840
2840
2560
2400

4.0567) 359.0200 (87.8508
326936×
329840
280069
347710
326936
20774
20433
3400
3269
1356

4.2369) 359.0200 (84.7365173
238952×
120068
169476
312040
296583
154570
127107
27463
25421
2041
1695

4.4002) 359.0200 (81.5917
352976×
70040
44002
26038
22010
4028
3960
68
44
24
22
2

4.5781) 359.0200 (78.4212
204677×
38530
36624
1906
1831
75
60
15
9
6
5
1
0

~~379.02200~~

0.67875550 — 1.16103840 × 70 = 1.16103740

0.69777610 — 1.22771666 × 26 = 1.22771692

0.71778570

0.73893311 — 1.30552233 × 24 = 1.30552427

0.76131113

0.78500663 — 1.40165900 × 34 = 1.40166624

0.81035335

0.83736611 — 1.52558220 × 32 = 1.52558232

0.86634005

0.89755556

0.93137140 — 1.70115534 × 20 = 1.70115594

0.96824000

1.00872790 — 2.00144350 × 130 = 2.00144450

1.10388221 — 0.53673735

103.8960

35.902) 3356.87 00 (99.40115
3231718 ×
337520
323118
146020
143605
2415 00
35902
52860
35902
10958
99.40115
× 36.782
198850230
8946610035
6858080805
7964060900
2982203395
3.7008) 3656.6 6 7 1 0 8 0 (98.79397
3330722 ×
325447
296064
293831
259056
34775 1
33327 =
1457 90
1 4 5 0 24
3576 68
3330 972
245 860
220 048
23 912
98.79397
× 3.7008
79035176
88914573

1.99947306
0.57795664
2.57742970
.5822 5293
1.99322677
.5937 7224
2.58624401
596 3771
1.98995830
609 9285
2.58859155
611 3725
1.98751557
6247667
2.61228554
627 0452
1.98523372
641 2460
2.62648332
643 4724
1.98301058
658 5074
2.64151826
660 6853
1.98083229
676 6296
2.65746225
678 7550
1.97870075
695 6830
2.67439305
697 7610
1.97662295
715 7527
2.69238222
717 7870
1.97459542

26
2.621
206
2.527
8721
230
8960
4469
120
4589
0354
90
6474
5935
130
6065
1666
26
1892
9948
165
10056
5232
109
5427

1.97445952
7369380
2.71153332
7389311
1.97226021
7593365
2.73319677
7613113
1.97065654
7831661
2.75381165
7550663
1.96875002
8084811
2.77523113
8103315
1.96658778
8355326
2.80234098
8376611
1.96504987
8645407
2.82958984
8663405
1.96324989
8857871
2.85803366
8975556
1.96149805
9296382
2.88119196
9313714
1.95997476

1.95997476
966 5359
2.92628335
968 2460
1.95804335
1.0076561
2.96564996
.0087279
1.95637717
1.05519624
3.00833341
1.05360654
1.95347287
1.102 2827
3.05501174
1.103 8960
1.95311154
1.15945850
3.1125743
1.16510474
1.95152659
1.22560551
3.177 1334
1.227 1662
1.94994642
1.304 0056
3.253 8628
1.305 5427
1.94894271
1.400 1493
3.3485764
1.401 6624
1.94469140

778
276
1054

1.94469140
1.5249 3377
3.47125517
1.5251 8272
1.94454245
1.5996920
3.64511165
1.701 1594
1.94395571
2.
3.94395571
2.00144451
1.94225120

178

60382
60254
60000
59616
59106
55466
56700
55506
54726
53636
52358
50954
49422
47762
45874
44058
42014
39547
37544
35118
32564
29552
27074
24136
21072
17578
14558
11410
7534
3532
1213250

2467
2333
.0734
.0268

1213250 circular mils.

6 ft. long.

~~10~~

.00000302705325
2132500
15135266250
6659410650
9081159975
3027053325
6659410650
3027053325
3,672572355566250
660
220,354343337500 lb.

15-1
14

29
1
30
150
150
32
2450
225

225
1
224
3
221
2
216

7
30
3832
1915
19160
19160
3832
3832
19160
19160
3832
3832
19160
19160
3832
3832

180

$$\frac{10000}{1002069} + \frac{1}{100} = \frac{1000000 + 1002069}{1002069}$$

$$2002069)\ 100206900\ (50.0532$$

$$\begin{array}{r} 10034 \\ 100103450 \\ \hline 1064500 \\ 1001034 \\ \hline 63465500 \\ 60062069 \\ \hline 3403430 \\ 2002069 \\ \hline 1401360 \end{array}$$

$$\times\ .1071$$

$$50.1603$$

$$\frac{10000}{501603} + \frac{1}{100} = \frac{1000000 + 501603}{501603}$$

$$1501603)\ 50160300\ (33.4041$$

$$\begin{array}{r} 45048209 \\ \hline 5112210 \\ 4504209 \\ \hline 607001 \\ 2021412 \\ \hline 6759800 \\ 6006412 \\ \hline 753388 \end{array}$$

$$\times\ .0741$$

$$33.4786$$

$$\frac{10000}{334786} + \frac{1}{100} = \frac{1000000 + 334786}{334786}$$

$$1334786)\ 33478600\ (25.0816$$

$$\begin{array}{r} 26695727 \\ \hline 6782873 \\ 6673930 \\ \hline 1089500 \\ 1067828 \\ \hline 21672 \end{array}$$

$$\times\ .0577$$

$$25.1393$$

$$\begin{array}{r} 1334786 \\ \hline 832340 \\ 500871 \end{array}$$

$$\frac{10000}{251393} + \frac{1}{100} = \frac{1000000 + 251393}{251393}$$

$$1251393)\ 25139300\ (20.0891$$

$$\begin{array}{r} 25022786 \\ \hline 1144000 \\ 1002572 \\ \hline 1001144 \\ 1132856 \\ 1001144 \\ \hline 131712 \\ 112623 \\ \hline 19089 \end{array}$$

$$\times\ .0480$$

$$20.1371$$

$$\frac{10000}{201371} + \frac{1}{100} = \frac{1000000 + 201371}{201371}$$

$$1201371)\ 20137100\ (16.7618$$

$$\begin{array}{r} 12013710 \\ \hline 8123390 \\ 7208226 \\ \hline 915164 \\ 840959 \\ \hline 74205 \\ 72822 \\ \hline 2383 \\ 1201 \\ \hline 1182 \\ 1201 \\ \hline 981 \\ 840 \\ \hline 141 \end{array}$$

$$\times\ .0417$$

$$16.8035$$

$$\frac{10000}{168035} + \frac{1}{100} = \frac{1000000 + 168035}{168035}$$

$$1168035)\ 16803500\ (14.3861$$

$$\begin{array}{r} 11680350 \\ \hline 5123150 \\ 4672140 \\ \hline 451010 \\ 350701 \\ \hline 100309 \\ 93929 \\ \hline 7380 \\ 7008 \\ \hline 372 \end{array}$$

$$\times\ .0373$$

$$14.9234$$

$$\begin{array}{r} 1168035 \\ \hline 1484900 \\ 1168035 \end{array}$$

182

$$\frac{10000}{144234} + \frac{1}{100} = \frac{1000000 + 144234}{14423400}$$

```
1144234)14423400(12.6053
        1144234×      .0347
        28856060
        22884685
         6925920
         6654404
          271600
          271122
           33043000
           22884468
           10158320
```

$$\frac{10000}{126394} + \frac{1}{100} = \frac{1000000 + 126394}{12639400}$$

```
1126394)12639400(11.2211
        1126394×      .0317
        1375460
        1126394
         249066
         225278
          23788200
          22527885
           1259320
           1126394
            132926
```

$$\frac{10000}{1125528} + \frac{1}{100} = \frac{1000000 + 1125528}{112552800}$$

```
1125528)112552800(10.1146
        1125528×      .0300
        1275200
        1125528
         1626720
         1125528
          5141920
          4505112
           636808
           565528
            71280
```

$$\frac{10000}{101446} + \frac{1}{100} = \frac{1000000 + 101446}{10144600}$$

183

```
1101446)10144600(9.2103
        9913014
         231586
         220289
          11296
          10144
           1152
           1101
             51
             44
              7
```

$$\frac{10000}{92390} + \frac{1}{100} = \frac{1000000 + 92390}{9239000}$$

```
1092390)9239000(8.4576
        8739120
         499880
         436956
          62924
          54619
           8305
           7646
            659
```

$$\frac{10000}{84854} + \frac{1}{100} = \frac{1000000 + 84854}{8485400}$$

```
1084854)8485400(7.8217
        7598978
         886422
         867883
          18539
          10708
           7831
           1084
           6747
```

$$\frac{10000}{75488} + \frac{1}{100} = \frac{1000000 + 75488}{7548800}$$

```
1075488)7548800(7.2776
        7549416
         299384
         215697
          83687
          75494
           8193
           7549
            644
```

$$184\ \frac{\cancel{10000}}{73044} + \frac{1}{100} = \frac{1000000 + 73044}{7304400}$$

```
1073044) 7304400 (6.8072
         6438264
          8661360
          8584335
           7700800
           7511308
           1899920
```

3.64975 : 3.41645 :: 100.

```
2.0000000
0.5335751
2.5335751
 5622632
1.971319
 8329685
2.5047264
 8396686
1.969611
 8619582
2.8316000
 8635845
1.968015
 8933012
2.8613167
 8948033
1.8655134
 9372471
2.8937605
 9286723
1.9650882
 9642738
2.9293620
 9656250
1.8637370.
 1.0049487
2.9686857
 1.0062349
1.9624508
```

```
1.9624508
1.0503355
3.0124863
1.0571266
1.9672257
1.1005532
3.0617789
1.1017264
1.9600525
1.1579431
3.1179956
1.1580676
1.9589280
1.2243306
3.1832584
1.2253998
1.9578588
1.3029805
3.2608193
1.3039970
1.9568223
1.3993552
3.3561775
1.4003532
1.9555243
1.5230850
3.4796293
```

```
3.4796293
1.5247673
1.9548620
1.6994318
3.6542938
1.7003601
1.9539337
2.0000000
2.9539337
2.0008976
11.8530361
```

```
1.9.6961118
2.
3.9696118
1.9713119
1.9982999
1.9680155
3.9663154
1.9696118
1.9967036
1.9665134
3.9632170
1.9680155
1.9952015
1.9650882
3.9602897
1.9665134
1.9937763
1.9637370
3.9575133
1.9650882
1.9924251
```

(R)

```
1.9924251
1.9624508
3.9548759
1.9637370
1.9911389
1.9612257
3.9523646
1.9624508
1.9899138
1.9600525
3.9499663
1.9612257
1.9887406
1.9558920
3.9476686
1.9600525
1.9876161
1.9557858
3.9455749
1.9558920
1.9865469
1.9556223
3.9433692
1.9557858
1.9855104
1.9555243
3.9411347
1.9556223
1.9845125
1.9554863
3.9399744
1.9555243
1.9835501
```

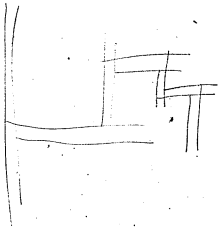
186

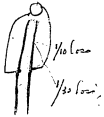
1,9835501
1,95-39337
1,93774838
1,95-48620
1,98262218
1,95-30361
3,93565579
1,95-39337
1,98172242

1,97,13119

4

1,97131 19
2,028 6681
0 28 65 26
35 55





1/30.

188

$m = \frac{10.642L}{R}$

$R = \frac{10.642L}{m}$

$m = 10.642 \times 60 \times \frac{30}{20}$

10.642
180
851360
10642
1915.560

10.642
120
21.2840
10642
1277.0400

$m = \frac{10.642 \times 120}{R} = \frac{1277}{R}$

1277
29
11893
2554
6|37033
6172

1277
56
7662
6385
6|71512
11919

1277
81
1277
10216
6|103437
17239

1277
104
5108
1277
6|132808
22135

1277
125
6385
2554
1277
6|159625
26604

1277
144
5108
5108
1277
6|183888
30648

1277
158
11493
2554
1277
6|201353
40225

1277
3
13831
1277
7662
6385
71543
1277
345
6375
5108
35311
40555

1277
761
1277
7662
1277
6|205597
34266

1277
176
7662
8939
1277
6|224752
37459

1277
200
6|255400
42567

1277
209
11493
2554
6|266893
44482

1277
216
7662
1277
2554
6|275832
45972

1277
221
1277
2554
2554
6|282217
47036

1277
224
5108
2554
2554
6|286048
47675

1277
227
6385
2554
2554
6|287325
47888

1277
930
38310
11493
~~1187670~~
~~1197935~~
~~1595~~
989675
989675
192935
306799 2 In feeding system

In district-
eating system
956686
120
908798
47888

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3190 00
2628 03
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227.153 6
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2176) 560.00 (.257735
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1.6000
1.5332
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65 28
11500
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2352) 1120.00 (.476.98
940.8x
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164688
145160
141112
4880
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2128
1881
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2116

450) 1.00 (.0133333
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217) 6.00 (.0276
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4667
0133
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4667
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Pudis. pyp. 956686

In feeding pyp. 1314865

Each 60 ft. long.

84830
565
4241150
424150
84830
1314865

450
224
221
216
209
220
189
176
161
144
125
104
81
56
29

00000 3027053235
956686
1816231950
2421692600
1816231950
1816231950
15135266625
27243979225
2895793946522950
173756367931770000

00000 3027053235
1314865
15135266625
1816231950
2421692600
1216821300
3027053235
9081159975
3027053235
3.980166371561250
238809982293665000

2240
112
2352

238.81
173.76
412.57
2

525.14

15
14
74
15
224

2120
56
2176

198

~~4762~~ 1120/2352	= .4762	100.4762
		.0286
3/105	= .0286	100.5048
		.0285
3/104	= .0288	100.5336
		.0294
3/102	= .0294	100.5630
		.0303
3/99	= .0303	100.5933
		.0316
3/95	= .0316	100.6249
		.0333
3/90	= .0333	100.6582
		.0357
3/84	= .0357	100.6939
		.0390
3/77	= .0390	100.7329
		.0435
3/69	= .0435	100.7764
		.0500
3/60	= .0500	100.8264
		.0600
3/50	= .0600	100.8864
		.0769
3/39	= .0769	100.9633
		.1111
3/27	= .1111	101.0744
		.2143
3/14	= .2143	101.2887

199

560/2176	= .2574	100.2574
		.1071
3/28	= .1071	100.3645
		.1111
3/27	= .1111	100.4756
		.1200
3/25	= .1200	100.5956
		.1364
3/22	= .1364	100.7320
		.1667
3/18	= .1667	100.8987
		.2308
3/13	= .2308	101.1295
		.4286
3/7	= .4286	101.5581

.158) 100.000 (.0595
.790
1.580
1.580
.0500
.0301
.0200
.0100

200

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  454399
   23944
  478343
```

In dis, system
2nd 86.878 lbs.

In feeding system
2nd 119,405 lbs.

6/225 = 10/168

168 | 10.000000 (.06
      10 08

225 | 6.000 (.0666
      5 500
      1 350
      1 350

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 .00000 30270532 5
        21454
 5-95-95-2
 119190
        121082130 0
       1513526625
      121082130 0
     302705325
    6054106 5-0
  .0649424 0 0.425 5 0
      5
  .5-19 5-39.2
      60
 31.17235.52 Ans.
 .00000 30270532 5
        119190
      27243479250
     302705325
   27243479 25
   3027053 25
  302705325
  .3.6 0.7944 8 6 6 6 7 5 9
       60
 21.647668 80 Ans.
```

201

```
   1277
3 | 89839
   2980

   1277
     13
   3831
   1277
3 | 7660 1
   5-5-34
21454
171632

   1277
     18
  10216
   1277
3 | 22986
   7662

   1277
     22
   2554
  2554
3 | 28094
   9365

   1277
     25
3 | 31925
  10642

   1277
     27
   8939
  2554
3 | 34479
  11493

   1277
     28
  10216
  2554
3 | 35756
  11919

   1277
     65
  10216
   7662
   1277
10 | 21456
   21459
```

In feeding system
1st 31.172 lbs.

In dis, system
1st 21.648 lbs.

```
31.172
21.648
86.878
119.405
259.103
```

518.206

x E-172

Table of Volt-ohms-Foot-lbs.

Volts	Squared	Logarithm (1 Volt-ohm per minute = 44.3; log = 1.646404)	Foot-lbs.	
1	1	0.000000	44.3	1
		1.646404		
2	4	0.602060		
		2.248464	177.2	2
3	9	0.954243		
		2.600647	398.7	3
4	16	1.204120		
		2.850524	708.8	4
5	25	1.397940		
		3.044364	1107.5	5
6	36	1.556303		
		3.202767	1594.8	6
7	49	1.690196		
		3.336600	2170.7	7
8	64	1.806180		
		3.452584	2835.2	8
9	81	1.908485		
		3.554889	3588.3	9
10	100	2.000000		
		3.646404	4430.0	10
11	121	2.082785		
		3.729189	5360.3	11
12	144	2.158363		
		3.804767	6379.2	12
13	169	2.227887		
		3.874291	7486.7	13
14	196	2.292256		
		3.938660	8682.8	14
15	225	2.352183		
		3.998587	9967.5	15
16	256	2.408240		
		4.054646	11341.	16
17	289	2.460898		
		4.107302	12803.	17
18	324	2.510545		
		4.156949	14353.	18
19	361	2.557507		
		4.203911	15992.	19
20	400	2.602060		
		4.248464	17720.	20
21	441	2.644439		
		4.290843	19536	21
22	484	2.684845		
		4.331249	21441	22
23	529	2.723456		
		4.369860	23435	23
24	576	2.760422		
		4.406826	25519	24
25	625	2.795880		
		4.442284	27689	25

Roots.	Squares.	Logarithms	Prod.-Logs.	
26	676	2,829947 4,476351	29947	26
27	729	2,862728 4,509132	32295	27
28	784	2,894316 4,540720	34732	28
29	841	2,924796 4,571200	37256	29
30	900	2,954243 4,600647	39870	30
31	961	2,982723 4,629127	42572	31
32	1024	3,010300 4,656704	45363	32
33	1089	3,037028 4,683432	48243	33
34	1156	3,062958 4,709362	51212	34
35	1225	3,088136 4,734540	54268	35
36	1296	3,112605 4,759009	57413	36
37	1369	3,136403 4,782807	60647	37
38	1444	3,159567 4,805971	63969	38
39	1521	3,182129 4,828533	67380	39
40	1600	3,204120 4,850524	70880	40
41	1681	3,225568 4,871972	74469	41

Volts	Squared	Logarithm	Foot-lbs.	
42	1764	3.246499 4.892903	78145	42
43	1849	3.266937 4.913341	81911	43
44	1936	3.286905 4.933309	85765	44
45	2025	3.306425 4.952829	89708	45
46	2116	3.325516 4.971920	93739	46
47	2209	3.344196 4.990600	97859	47
48	2304	3.362483 5.008887	102070	48
49	2401	3.380392 5.026796	106360	49
50	2500	3.397940 5.044344	109760	50
51	2601	3.415140 5.061544	115220	51
52	2704	3.432007 5.078411	119790	52
53	2809	3.448552 5.094956	124440	53
54	2916	3.464788 5.111192	129180	54
55	3025	3.480725 5.127129	134010	55

282

Volts	Squared	Logarithm	Foot-lbs.	
56	3136	3.496376 5.142780	138920	56
57	3249	3.511750 5.158154	143930	57
58	3364	3.526856 5.173260	149030	58
59	3481	3.541704 5.188108	154210	59
60	3600	3.556303 5.202707	159480	60
61	3721	3.570660 5.217064	164840	61
62	3844	3.584783 5.231187	170290	62
63	3969	3.598681 5.245085	175830	63
64	4096	3.612360 5.258764	181450	64
65	4225	3.625827 5.272231	187170	65
66	4356	3.639089 5.285493	192970	66
67	4489	3.652150 5.298554	198860	67
68	4624	3.665018 5.311422	204840	68
69	4761	3.677698 5.324102	210910	69
70	4900	3.690196 5.336600	217070	70

Volts	Squared	Logarithm	Tool-lbs.	
71	5041	3,7025517 5,3478921	223320	71
72	5184	3,7146655 5,3610699	229650	72
73	5329	3,7266446 5,3730550	236080	73
74	5476	3,7384663 5,3848997	242590	74
75	5625	3,7501723 5,3965247	249190	75
76	5776	3,7616627 5,4080031	255880	76
77	5929	3,7729952 5,4193386	262660	77
78	6084	3,7841189 5,4305593	269520	78
79	6241	3,7952255 5,4418165	276470	79
80	6400	3,8061800 5,4525584	283520	80
81	6561	3,8169970 5,4633374	290650	81
82	6724	3,8276628 5,4740032	297870	82
83	6889	3,8381156 5,4845560	305180	83
84	7056	3,8485559 5,4949963	312580	84
85	7225	3,8588838 5,5052242	320070	85
86	7396	3,8689997 5,5154401	327640	86

Volts	Squared	Logarithm	Footlbs.	
87	7569	3.879039 5.525743	335310	87
88	7744	3.888965 5.535369	343060	88
89	7921	3.898780 5.545184	350900	89
90	8100	3.908485 5.554889	358830	90
91	8281	3.918083 5.564487	366850	91
92	8464	3.927576 5.573980	374960	92
93	8649	3.936967 5.583371	383150	93
94	8836	3.946256 5.592660	391440	94
95	9025	3.955447 5.601851	399820	95
96	9216	3.964543 5.610947	408270	96
97	9409	3.973544 5.619948	416820	97
98	9604	3.982452 5.628856	425460	98
99	9801	3.991270 5.637674	434190	99
100	10000	4.000000 5.646404	443000	100

Volts	Squared	Logarithm	Foot-lbs.
101	10201	4.0086427 5.6550464	101 451900
102	10404	4.0172003 5.6636040	102 460900
103	10609	4.0256744 5.6720781	103 469980
104	10816	4.0340667 5.6804704	104 479150
105	11025	4.0423786 5.6887823	105 488410
106	11236	4.0506117 5.6970154	106 497750
107	11449	4.0587676 5.7051713	107 507190
108	11664	4.0668475 5.7132512	108 516720
109	11881	4.0748530 5.7212567	109 526330
110	12100	4.0827854 5.7291891	110 536030
111	12321	4.0906460 5.7370497	111 545820
112	12544	4.0984360 5.7448397	112 555700
113	12769	4.1061569 5.7525606	113 565590
114	12996	4.1138097 5.7602134	114 575720
115	13225	4.1213957 5.7677994	115 585870

12

Roots	Squares	Logarithm	Roots	Lbs.
116	13456	4.1289160		
		5.7753197	116	596100
117	13689	4.1363717		
		5.7827754	117	606420
118	13924	4.1437640		
		5.7901677	118	616830
119	14161	4.1510439		
		5.7974976	119	627330
120	14400	4.1583625		
		5.8047662	120	637920
121	14641	4.1655707		
		5.8119744	121	648600
122	14884	4.1727197		
		5.8191234	122	659360
123	15129	4.1798102		
		5.8262139	123	670210
124	15376	4.1868434		
		5.8332471	124	681160
125	15625	4.1938200		
		5.8402237	125	692190
126	15876	4.2007411		
		5.8471448	126	703310
127	16129	4.2076074		
		5.8540111	127	714520
128	16384	4.2144199		
		5.8608236	128	725810
129	16641	4.2211794		
		5.8675831	129	737200
130	16900	4.2278867		
		5.8742904	130	748670

Volts	Squared	Logarithm	Foot-lbs.
131	17161	4.2345426 5.8809463	131 760230
132	17424	4.2412226 5.8876263	132 772020
133	17689	4.2477033 5.8941070	133 783820
134	17956	4.2542096 5.9006133	134 795450
135	18225	4.2606675 5.9070712	135 807370
136	18496	4.2670778 5.9134815	136 819370
137	18769	4.2734411 5.9198448	137 831470
138	19044	4.2797582 5.9261619	138 843650
139	19321	4.2860296 5.9324333	139 855920
140	19600	4.2922561 5.9386598	140 868280
141	19881	4.2984382 5.9448419	141 880730
142	20164	4.3045767 5.9509804	142 893260
143	20449	4.3106721 5.9570758	143 905890
144	20736	4.3167250 5.9631287	144 918600
145	21025	4.3227360 5.9691397	145 931410

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Roots.	Squares	Logarithm	Fort-Ulz.
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147	21609	4.3346347 5.9810384	147 957280
148	21904	4.3405234 5.9869271	148 970350
149	22201	4.3463725 5.9927762	149 983500
150	22500	4.3521825 5.9985862	150 996750
151	22801	4.3579539 6.0043576	151 1010080
152	23104	4.3636872 6.0100909	152 1023500
153	23409	4.3693829 6.0157866	153 1037020
154	23716	4.3750414 6.0214451	154 1050620
155	24025	4.3806634 6.0270671	155 1064300
156	24336	4.3862492 6.0326529	156 1078090
157	24649	4.3917993 6.0382030	157 1091950
158	24964	4.3973142 6.0437179	158 1105950
159	25281	4.4027942 6.0491979	159 111995[illegible]
160	25600	4.4082400 6.0546437	160 1134[illegible]

Volts	Squared	Logarithm	Ans-Ohms
161	25921	4.4136578 6.0600555	161 1148300
162	26244	4.4190300 6.0654337	162 1162610
163	26569	4.4243752 6.0707789	163 1177000
164	26896	4.4296877 6.0760914	164 1191480
165	27225	4.4349679 6.0813716	165 1206010
166	27556	4.4403318 6.0867275	166 1221170
167	27889	4.4454329 6.0918366	167 1235480
168	28224	4.4509262 6.0973299	168 1251210
169	28561	4.4557734 6.1021771	169 1265250
170	28900	4.4608978 6.1073015	170 1280270
171	29241	4.4659922 6.1123959	171 1295370
172	29584	4.4710569 6.1174606	172 1310570
173	29929	4.4760922 6.1224959	173 1325850
174	30276	4.4810985 6.1275022	174 1341230
175	30625	4.4860761 6.1324798	175 1356690
176	30976	4.4910253 6.1374290	176 1372230

Volts	Squared	Logarithm	Foot-lbs
177	31329	4.4959465 6.1923502	177 1387870
178	31684	4.5008400 6.1972937	178 1403600
179	32041	4.5057061 6.1521898	179 1419420
180	32400	4.5105450 6.1569987	180 1435320
181	32761	4.5153571 6.1617608	181 1451310
182	33124	4.5201428 6.1665465	182 1467390
183	33489	4.5249022 6.1713059	183 1483560
184	33856	4.5296356 6.1760393	184 1499820
185	34225	4.5343435 6.1807472	185 1516170
186	34596	4.5390259 6.1854296	186 1532600
187	34969	4.5436832 6.1900869	187 1549130
188	35344	4.5483157 6.1947194	188 1565740
189	35721	4.5529236 6.1993273	189 1582440
190	36100	4.5575072 6.2039109	190 1599230
191	36481	4.5620667 6.2084704	191 1616110
192	36864	4.5666025 6.2130062	192 1634080

2220072
2219877
195

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155
73

362
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98

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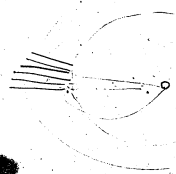
93

Volts	Squared	Logarithms	Foot-lbs.
193	37249	4.5711146 6.2175183	193 1650130
194	37636	4.5756035 6.2220072	194 1667300
195	38025	4.5800692 6.2264729	195 1684570
196	38416	4.5845521 6.2309158	196 1701830
197	38809	4.5888325 6.2353362	197 1719240
198	39204	4.5933309 6.2397341	198 1736740
199	39601	4.5977062 6.2441099	199 1754320
200	40000	4.6020600 6.2484637	200 1772000

Feb. 8th 1880,

Volts.	Foot-lbs.	Volts.	Foot-lbs
201	1789760	218	2105320
202	1807600	219	2124680
203	1825560	220	2144120
204	1843600	221	2163660
205	1861720	222	2183280
206	1879920	223	2203000
207	1898220	224	2222800
208	1916600	225	2242540
209	1935080	226	2262360
210	1953640	227	2282580
211	1972280	228	2302880
212	1991000	229	2323140
213	2002650	230	2343480
214	2014380	231	2363900
215	2036590	232	2384400
216	2058880	233	2404000
217	2082060	234	2425680
		235	2446460

Volts	Foot-lbs.	Volts	Foot-lbs.
236	2467320	252	2813240
237	2488280	253	2835620
238	2509320	254	2858080
239	2530460	255	2880620
240	2551680	256	2903240
241	2573000	257	2925980
242	2594400	258	2948800
243	2615880	259	2971700
244	2637440	260	2994680
245	2659100	261	3017760
246	2680840	262	3040920
247	2702700	263	3064460
248	2724640	264	3088080
249	2746660	265	3111240
250	2768760	266	3134480
251	2790980	267	3158100



Volts.	Foot-lbs.	Volts.	Foot-lbs.
268	3181800	283	3547940
269	3205600	284	3573040
270	3229480	285	3598260
271	3253440	286	3623560
272	3277480	287	3648940
273	3301640	288	3674400
274	3325880	289	3699980
275	3350200	290	3725640
276	3374600	291	3751380
277	3399100	292	3777200
278	3423680	293	3803120
279	3448360	294	3829120
280	3473120	295	3855220
281	3497980	296	3881400
282	3522920	297	3907660
		298	3934000
		299	3960460
		300	3987000

257

Volts	Foot-lbs.	Volts	Foot-lbs.
301	4013620	318	4479800
302	4040320	319	4508020
303	4067120	320	4536320
304	4094000	321	4564720
305	4121000	322	4593200
306	4148080	323	4621780
307	4175240	324	4650440
308	4202480	325	4679180
309	4229800	326	4708000
310	4257200	327	4736920
311	4284740	328	4765920
312	4312360	329	4794980
313	4340040	330	4824040
314	4367800	331	4854320
315	4395760	332	4884680
316	4423800	333	4913260
317	4451760	334	4941920
		335	4973340

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2113571375 0
1907043575 75
20652817750
19070435475
1582387275 0
1583258092 5
2812618250
8475749100
12069869150 0
12713623650
16550678500
14832560925
17181175750
6585149820 0
2297577500
2118937275

Volts.	Foot-lb.	Volts.	Foot-lb.
336	5004840	353	5520160
337	5032880	354	5551480
338	5061000	355	5582900
339	5091000	356	5614400
340	5121080	357	5646000
341	5151240	358	5677680
342	5181480	359	5709440
343	5211840	360	5741280
344	5242280	361	5773220
345	5272800	362	5805240
346	5303400	363	5837360
347	5334120	364	5869560
348	5364920	365	5901860
349	5395800	366	5934240
350	5426760	367	5966720
351	5457840	368	5999280
352	5488920	369	6031940
		370	6064680

212

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        .27340
        1,185.2
        54650
       136700
     218720
     27340
     27340
12124 / 3240.3368 \ 26727
        24248
         81553
         72744
          85096
          84868
           32288
           24248
            80.00
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Velocity	Foot-lbs.	Velocity	Foot-lbs.
371	6097000	388	6669200
372	6130400	389	6703580
373	6163420	390	6738040
374	6196520	391	6772640
375	6229700	392	6807320
376	6262960	393	6842100
377	6296320	394	6876960
378	6329760	395	6911920
379	6363300	396	6946960
380	6396920	397	6982080
381	6430640	398	7017280
382	6464440	399	7052600
383	6500340	400	7088000
384	6536320		
385	6568380		
386	6600520		
387	6634820		

Volts.	Foot-lbs.	Volts.	Foot-lbs.
401	7123480	417	7703320
402	7159040	418	7740320
403	7194680	419	7777400
404	7230400	420	7814560
405	7266280	421	7851800
406	7302240	422	7889120
407	7338280	423	7926520
408	7374400	424	7964000
409	7410600	425	7987280
410	7446880	426	8010600
411	7483260	427	8034020
412	7519680	428	8057520
413	7556280	429	8101900
414	7592880	430	8146360
415	7629600	431	8190900
416	7666400	432	8235520
		433	8281840
		434	8328240

Volts.	Foot-lbs.	Volts.	Foot-lbs.
435	8374720	451	901.0210
436	8421280	452	9049440
437	8459960	453	9089840
438	8498720	454	9130320
439	8537580	455	9170880
440	8576480	456	9211520
441	8615520	457	9252000
442	8654640	458	9292560
443	8693840	459	9333200
444	8733120	460	9373920
445	8772520	461	9414720
446	8812000	462	9455600
447	8851600	463	9496580
448	8891200	464	9537600
449	8931090	465	9578780
450	8970160	466	9620000
		467	9661320

Vol.	Foot-lbs.	Vol.	Foot-lbs.
468	9702720	485	10420520
469	9744240	486	10463520
470	9785840	487	10506600
471	9827520	488	10549760
472	9869280	489	10593040
473	9911160	490	10636400
474	9953120	491	10679840
475	9995160	492	10723360
476	10037280	493	10767040
477	10079520	494	10810800
478	10121840	495	10854640
479	10164240	496	10898560
480	10206720	497	10942560
481	10249320	498	10986640
482	10292000	499	11030800
483	10334760	500	11075040
484	10377600		

Feb. 1880.

Table of Resistances for Varying temperature.

Conductivity of Copper taken at 97 therefore resistance at 0°C. = .21278 ohms per foot-gram.

Mathiessen's formula for resistance is $R = r(1 + at \pm bt^2)$, in which r is the resistance (.21278) at 0°C. The formula for Fahrenheit becomes

$$R = r\left[1 + \tfrac{5}{9}a(t-32) \pm b\left(\tfrac{5}{9}\right)^2(t-32)^2\right].$$

$a = .003824$, $b = .00000126$

$$\therefore R = .21278\left[1 + .0021244(t-32) + .0000003889(t-32)^2\right]$$

In this table the column of ratios is true for any metal but not for alloys. Let R' be the resistance of 1 foot 1 gram of any copper and R the resistance for any temperature as found in Col. 3. Then

$$R' = \frac{R \times 97}{C}.$$

It would be nice to have a column for mil-feet; and also the even C. degrees.

April 2, 1890. Clarke.

Note Book 55.

The weight of a mil-foot of copper is .021189372 75 grains and in one gram-foot there will be 47.193469 mil-feet, therefore to find the resistance per mil-foot of copper having a conductivity of 97, multiply the resistance at any desired temperature as found in Col. 3 by 47.193469. or if the copper have a different conductivity C, applying formula on preceding page we have,

$$\text{Res. per mil-foot} = 47.193469\left(\frac{R \times 97}{C}\right).$$

Since a mil-foot of copper of a sp. gr. of 8.899 weighs .021189372 75 grains the weight of any other metal per mil-foot having a sp. gr. of S will be

$$\frac{.021189372\,75 \times S}{8.899} = .002381096\,S \text{ grains}$$

See 6 pages ahead

Temp. Fahr.	Temp. Cent.	Resistance per Foot-gram	Rates of Resistance to Resistance at 60° F.	Temp. Fahr.	Temp. Cent.	Resistance per Foot-gram	Rates of Resistance that at 60° F. being 1
0	-17.78	.19839	.8798	25	-3.89	.20963	.9296
1	-17.22	.19884	.8818	26	-3.33	.21007	.9316
2	-16.67	.19929	.8838	27	-2.78	.21052	.9336
3	-16.11	.19973	.8857	28	-2.22	.21097	.9356
4	-15.56	.20018	.8877	29	-1.67	.21141	.9375
5	-15	.20063	.8897	30	-1.11	.21188	.9396
6	-14.44	.20107	.8917	31	-.56	.21233	.9416
7	-13.89	.20152	.8937	32	0	.21278	.9436
8	-13.33	.20197	.8956	33	.56	.21324	.9456
9	-12.78	.20241	.8976	34	1.11	.21368	.9476
10	-12.22	.20286	.8996	35	1.67	.21414	.9496
11	-11.67	.20331	.9016	36	2.22	.21459	.9516
12	-11.11	.20378	.9036	37	2.78	.21505	.9537
13	-10.56	.20422	.9056	38	3.33	.21550	.9557
14	-10	.20467	.9076	39	3.89	.21595	.9577
15	-9.44	.20512	.9096	40	4.44	.21640	.9597
16	-8.89	.20556	.9116	41	5	.21687	.9617
17	-8.33	.20603	.9137	42	5.56	.21731	.9637
18	-7.78	.20648	.9156	43	6.11	.21775	.9656
19	-7.22	.20692	.9176	44	6.67	.21820	.9676
20	-6.67	.20737	.9196	45	7.22	.21867	.9697
21	-6.11	.20780	.9216	46	7.78	.21912	.9717
22	-5.56	.20827	.9236	47	8.33	.21957	.9737
23	-5	.20871	.9256	48	8.89	.22001	.9757
24	-4.44	.20916	.9275	49	9.44	.22048	.9777

S E T

0° to 12° is 21.
12° to 22° is 21.1
22° to 32° is 21.2
32° to 42° is 21.3
42° to 52° is 21.3
52° to 62° is 21.4
62° to 72° is 21.5
72° to 82° is 21.6
82° to 92° is 21.7
92° to 102° is 21.8
102° to 112° is 21.8
112° to 122° is 21.9
122° to 132° is 22.
132° to 142° is 22.1
142° to 152° is 22.1
152° to 162° is 22.2

Temp. of Fahr.	Temp. Cent.	Resistance per Foot-grain	Ratio of Resistance to Resistance at 60°F.
50	10	.22092	.9797
51	10.56	.22138	.98.17
52	11.11	.22182	.9837
53	11.67	.22229	.9858
54	12.22	.22274	.9878
55	12.78	.22321	.9899
56	13.33	.22365	.9918
57	13.89	.22412	.9939
58	14.44	.22459	.9960
59	15	.22504	.9980
60	15.56	.22550	1
61	16.11	.22595	1.0020
62	16.67	.22642	1.0041
63	17.22	.22688	1.0062
64	17.78	.22733	1.0081
65	18.33	.22780	1.0102
66	18.89	.22825	1.0122
67	19.44	.22872	1.0143
68	20	.22916	1.0162
69	20.56	.22963	1.0183
70	21.11	.23008	1.0203
71	21.67	.23055	1.0224
72	22.22	.23099	1.0243
73	22.78	.23144	1.0263
74	23.33	.23189	1.0283

Temp. of Fahr.	Temp. Cent.	Resistance per Foot-grain	Ratio of Resistance to Resistance at 60°F.
75	23.89	.23233	1.0303
76	24.44	.23282	1.0325
77	25	.23329	1.0346
78	25.56	.23374	1.0365
79	26.11	.23421	1.0386
80	26.67	.23468	1.0407
81	27.22	.23512	1.0427
82	27.78	.23559	1.0447
83	28.33	.23606	1.0468
84	28.89	.23651	1.0489
85	29.44	.23697	1.0509
86	30	.23744	1.0529
87	30.56	.23791	1.0550
88	31.11	.23836	1.0570
89	31.67	.23882	1.0591
90	32.22	.23929	1.0612
91	32.78	.23974	1.0631
92	33.33	.24021	1.0652
93	33.89	.24068	1.0673
94	34.44	.24114	1.0693
95	35	.24159	1.0714
96	35.56	.24206	1.0734
97	36.11	.24253	1.0755
98	36.67	.24299	1.0776
99	37.22	.24346	1.0796

162° & 172°	22,3
172° & 182°	22,4
182° & 192°	22,5
192° & 202°	22,5
202° & 212°	22,6
202° & 222°	22,7
222° & 232°	22,8
232° & 242°	22,9
242° & 252°	22,9
252° & 262°	23.
262° & 272°	23,1
272° & 282°	23,2
282° & 292°	23,2
292° & 302°	23,3
300° & 320°	23,45
320° & 340°	23,55
340° & 360°	23,7
360° & 380°	23,9
380° & 400°	24.
400° & 450°	24,3
450° & 500°	24,7

Temp. of Fahr.	Temp. Cent.	Resistance per Ferrigram	Ratio of Resistance to Resistance at 60°F.
100	37.78	.24391	1.0816
101	38.33	.24438	1.0837
102	38.89	.24482	1.0857
103	39.44	.24529	1.0878
104	40	.24576	1.0898
105	40.56	.24621	1.0918
106	41.11	.24665	1.0938
107	41.67	.24714	1.0959
108	42.22	.24761	1.0980
109	42.78	.24808	1.1001
110	43.33	.24853	1.1021
111	43.89	.24900	1.1042
112	44.44	.24946	1.1063
113	45	.24993	1.1083
114	45.56	.25040	1.1104
115	46.11	.25087	1.1125
116	46.67	.25134	1.1146
117	47.22	.25180	1.1166
118	47.78	.25225	1.1186
119	48.33	.25272	1.1207
120	48.89	.25319	1.1228
121	49.44	.25366	1.1248
122	50	.25412	1.1270
123	50.56	.25459	1.1290
124	51.11	.25506	1.1312

Temp. of Fahr.	Temp. Cent.	Resistance per Ferrigram	Ratio of Resistance to Resistance at 60°F.
125	51.67	.25553	1.1332
126	52.22	.25600	1.1353
127	52.78	.25646	1.1373
128	53.33	.25693	1.1394
129	53.89	.25740	1.1415
130	54.44	.25787	1.1436
131	55	.25834	1.1456
132	55.56	.25880	1.1477
133	56.11	.25927	1.1498
134	56.67	.25974	1.1518
135	57.22	.26021	1.1539
136	57.78	.26068	1.1560
137	58.33	.26117	1.1582
138	58.89	.26163	1.1602
139	59.44	.26210	1.1623
140	60	.26257	1.1644
141	60.56	.26304	1.1665
142	61.11	.26351	1.1685
143	61.67	.26397	1.1706
144	62.22	.26444	1.1727
145	62.78	.26491	1.1748
146	63.33	.26537	1.1768
147	63.89	.26586	1.1790
148	64.44	.26633	1.1812
149	65	.26680	1.1832

and in one grain foot there will be $\frac{1}{.002381096\,S} = \frac{419.9746781}{S}$ mile-feet. If then we have given at any temperature the resistance, B, of any metal per grain foot, the resistance per mile-foot will be at that temperature

$$\frac{B}{S}(419.9746781).$$

Col. 4, holds good for the mile-foot as well as for the grain foot.

Let R be the resistance of any metal, at a given temperature per mile-foot, or grain-foot and m the corresponding ratio in Col. 4, also n the ratio corresponding to any other temperature and R' the resistance per mile-foot or grain-foot for that temperature then will

$$R' = \frac{Rn}{m}.$$

Temp. Fahr.	Temp. Cent.	Resistance per Foot-grain	Ratio of Resistance to Resistance at 60° F.	Temp. Fahr.	Temp. Cent.	Resistance per Foot-grain	Ratio of Resistance to Resistance at 60° F.
150	65.56	.26727	1.1852	175	79.44	.27910	1.2377
151	66.11	.26774	1.1873	176	80	.27959	1.2399
152	66.67	.26820	1.1894	177	80.56	.28006	1.2419
153	67.22	.26867	1.1915	178	81.11	.28052	1.2440
154	67.78	.26914	1.1935	179	81.67	.28101	1.2462
155	68.33	.26963	1.1957	180	82.22	.28148	1.2483
156	68.89	.27010	1.1978	181	82.78	.28197	1.2504
157	69.44	.27057	1.1999	182	83.33	.28244	1.2525
158	70	.27103	1.2019	183	83.89	.28293	1.2547
159	70.56	.27150	1.2040	184	84.44	.28340	1.2568
160	71.11	.27199	1.2062	185	85	.28389	1.2589
161	71.67	.27246	1.2082	186	85.56	.28435	1.2610
162	72.22	.27293	1.2103	187	86.11	.28484	1.2632
163	72.78	.27340	1.2124	188	86.67	.28531	1.2652
164	73.33	.27388	1.2146	189	87.22	.28580	1.2674
165	73.89	.27436	1.2166	190	87.78	.28627	1.2695
166	74.44	.27482	1.2187	191	88.33	.28676	1.2716
167	75	.27531	1.2209	192	88.89	.28723	1.2737
168	75.56	.27578	1.2230	193	89.44	.28772	1.2759
169	76.11	.27625	1.2250	194	90	.28819	1.2780
170	76.67	.27672	1.2271	195	90.56	.28867	1.2801
171	77.22	.27720	1.2293	196	91.11	.28914	1.2822
172	77.78	.27767	1.2314	197	91.67	.28963	1.2844
173	78.33	.27814	1.2334	198	92.22	.29010	1.2865
174	78.89	.27863	1.2356	199	92.78	.29059	1.2887

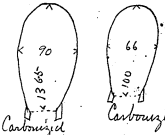
Temp. of Fahr.	Temp. Cent.	Resistance per Foot-gram	Ratio of Resistance to Resistance at 60°F.	Temp. of Fahr.	Temp. Cent.	Resistance per Foot-gram	Ratio of Resistance to Resistance at 60°F.
200	93.33	.29106	1.2907	225	107.22	.30310	1.3441
201	93.89	.29155	1.2929	226	107.78	.30359	1.3463
202	94.44	.29201	1.2950	227	108.33	.30408	1.3485
203	95	.29250	1.2971	228	108.89	.30455	1.3505
204	95.56	.29297	1.2992	229	109.44	.30504	1.3527
205	96.11	.29346	1.3014	230	110	.30553	1.3549
206	96.67	.29393	1.3035	231	110.56	.30599	1.3570
207	97.22	.29442	1.3056	232	111.11	.30648	1.3591
208	97.78	.29491	1.3078	233	111.67	.30697	1.3613
209	98.33	.29538	1.3099	234	112.22	.30746	1.3635
210	98.89	.29587	1.3120	235	112.78	.30795	1.3656
211	99.44	.29634	1.3139	236	113.33	.30844	1.3678
212	100	.29682	1.3163	237	113.89	.30893	1.3700
213	100.56	.29731	1.3185	238	114.44	.30940	1.3720
214	101.11	.29778	1.3205	239	115	.30989	1.3742
215	101.67	.29827	1.3227	240	115.56	.31038	1.3764
216	102.22	.29876	1.3249	241	116.11	.31087	1.3786
217	102.78	.29925	1.3271	242	116.67	.31136	1.3807
218	103.33	.29972	1.3291	243	117.22	.31184	1.3829
219	103.89	.30021	1.3313	244	117.78	.31233	1.3851
220	104.44	.30070	1.3335	245	118.33	.31282	1.3872
221	105	.30116	1.3355	246	118.89	.31331	1.3894
222	105.56	.30165	1.3377	247	119.44	.31380	1.3916
223	106.11	.30214	1.3398	248	120	.31427	1.3937
224	106.67	.30261	1.3420	249	120.56	.31476	1.3958

Temp. Fahr.	Temp. Cent.	Resistance per Foot-gram	Ratio of Resistance to Resistance at 60°F.	Temp. Fahr.	Temp. Cent.	Resistance per Foot-gram	Ratio of Resistance to Resistance at 60°F.
250	121.11	.31525	1.3980	275	135	.32753	1.4524
251	121.67	.31574	1.4002	276	135.56	.32802	1.4546
252	122.22	.31623	1.4023	277	136.11	.32851	1.4568
253	122.78	.31672	1.4045	278	136.67	.32899	1.4590
254	123.33	.31721	1.4067	279	137.22	.32948	1.4611
255	123.89	.31770	1.4089	280	137.78	.32998	1.4634
256	124.44	.31819	1.4110	281	138.33	.33048	1.4656
257	125	.31867	1.4132	282	138.89	.33095	1.4676
258	125.56	.31916	1.4154	283	139.44	.33144	1.4698
259	126.11	.31965	1.4175	284	140	.33193	1.4720
260	126.67	.32014	1.4197	285	140.56	.33244	1.4742
261	127.22	.32063	1.4219	286	141.11	.33293	1.4764
262	127.78	.32112	1.4240	287	141.67	.33342	1.4786
263	128.33	.32161	1.4262	288	142.22	.33391	1.4808
264	128.89	.32210	1.4284	289	142.78	.33440	1.4829
265	129.44	.32259	1.4306	290	143.33	.33491	1.4852
266	130	.32308	1.4327	291	143.89	.33540	1.4874
267	130.56	.32359	1.4350	292	144.44	.33589	1.4895
268	131.11	.32408	1.4372	293	145	.33638	1.4917
269	131.67	.32457	1.4393	294	145.56	.33689	1.4940
270	132.22	.32506	1.4415	295	146.11	.33738	1.4961
271	132.78	.32555	1.4437	296	146.67	.33787	1.4983
272	133.33	.32604	1.4459	297	147.22	.33838	1.5006
273	133.89	.32653	1.4480	298	147.78	.33887	1.5027
274	134.44	.32702	1.4502	299	148.33	.33936	1.5049

Temp. Temp. Fahr.	Cent.	Resistance per Foot-gram	Ratio of Resistance to Resistance at 60°F.	Temp. Temp. Fahr.	Cent.	Resistance per Foot-gram	Ratio of Resistance to Resistance at 60°F.
300	148.89	.33985	1.5071	450	232.22	.41619	1.8456
305	151.67	.34234	1.5181	460	237.78	.42145	1.8689
310	154.44	.34482	1.5291	470	243.33	.42670	1.8922
315	157.22	.34731	1.5402	480	248.89	.43196	1.9156
320	160	.34982	1.5513	490	254.44	.43721	1.9389
325	162.78	.35231	1.5624	500	260	.44245	1.9621
330	165.56	.35483	1.5735				
335	168.33	.35734	1.5846				
340	171.11	.35985	1.5958				
345	173.89	.36238	1.6070				
350	176.67	.36489	1.6181				
355	179.44	.36742	1.6294				
360	182.22	.36993	1.6405				
365	185	.37249	1.6518				
370	187.78	.37502	1.6630				
375	190.56	.37757	1.6744				
380	193.33	.38001	1.6856				
385	196.11	.38266	1.6969				
390	198.89	.38521	1.7082				
395	201.67	.38776	1.7195				
400	204.44	.39032	1.7309				
410	210	.39549	1.7538				
420	215.56	.40066	1.7768				
430	221.11	.40583	1.7997				
440	226.67	.41100	1.8226				

March 14th 1889

Carbon Loop

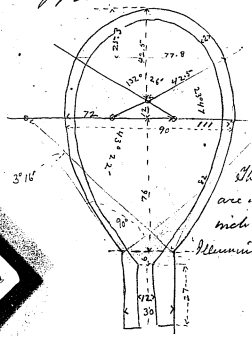


Not Carbonized — Carbonized

The mills are $80\frac{1}{100}$ of an inch.

The ratio of contraction by carbonizing is $\frac{4}{15}$.

March 15-4



Before embouchure

The dimensions are in 80th of an inch.

191.8
117.86
332.
(64000) 142,66 (.1004156 Surface in
64000
256000 face before car-
256000 bouzing.
10000
64000
360000
320000
40000
32000
8000
1600.0

Since the calculations have been made in 80th, we divide by (80)²:

Fig 2

2.1332.5
77.8

42.5)38.39(.9150588
38 25
670
425
2550
2125
2500
2125
3750
3400
3750
3400
3500
3400
100

132°26'
66°13'
23°47'

2.1332
43.22

5184
1960
284

111)41.0(.3693693
333
770
666
1040
888
1520
1332
1880
1665
2150

1806.25
1640.25
166.00

3.1416
166
188496
31416
521.5056

7946
5.2.21
39730
7946
15892
39730
216000) 47438.39 (191.8
216
1783
1728
398
216
1824
1728
969

3.1416
260
12566
251328
62832
8220.1.44

2854
592
5708
25686
22832
216000) 25457.68 (117.86
216000
38576
21600
169776
151200
185680
172800
12880.00

12321
11520
800

3.1416
260
125660
125660
13823.560

10908
4192
1256
1320
216000) 1320 (.333
1296
24
1.3
3.9
3.51
3.60

3000
2160
840

132°26'
66
7946
23°47'
7427
2854

12321
2.0.3
1320
1382

222

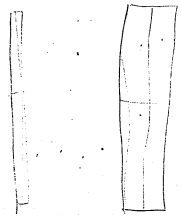
Shrinkage by Carbonizing

The linear dimensions diminish to $\frac{11}{15}$ th. and areas therefore are $\frac{121}{225}$ th of their value before carbonizing.

.10041 5-6
121
10041 5-6
20083 12
10041 5-6

225) 12.15028 78 (.05-4001
11 25 × × × ×
900
900
287

The area of the face of loop is therefore .054 sq. in.



$\frac{9000}{8000} = 1.125$

$\frac{9350}{8000} = 1.169$

$\frac{10250}{8000} = 1.281$

$\frac{11550}{8000} = 1.444$

$\frac{12650}{8000} = 1.581$

$\frac{13150}{8000} = 1.644$

$\frac{13050}{8000} = 1.631$

$\frac{12430}{8000} = 1.554$

$\frac{11150}{8000} = 1.394$

$\frac{9450}{8000} = 1.181$

$\frac{9220}{8000} = 1.154$

$\frac{7400}{8000} = 0.925$

$\frac{7700}{8000} = 0.963$

$\frac{5150}{8000} = 0.644$

$\frac{4450}{8000} = 0.506$

$\frac{3000}{8000} = 0.375$

$\frac{8600}{8000} = 1.750$

$\frac{8950}{8000} = 1.119$

$\frac{10000}{8000} = 1.250$

$\frac{11100}{8000} = 1.388$

$\frac{12350}{8000} = 1.531$

$\frac{12750}{8000} = 1.594$

$\frac{12700}{8000} = 1.588$

$\frac{12270}{8000} = 1.507$

$\frac{10900}{8000} = 1.363$

$\frac{9200}{8000} = 1.150$

$\frac{7800}{8000} = .975$

$\frac{2500}{8000} = .938$

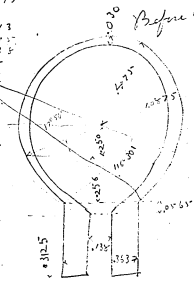
$\frac{6300}{8000} = .788$

$\frac{5000}{8000} = .625$

$\frac{5950}{8000} = .744$

$\frac{2975}{8000} = .372$

Before Carburizing



17°50'
35°40'
60
2140'

3.1416
.06433
1.7080
94248
125664
188496
.20216
214
85664
20216
40432
2160) 43.2622 24 (.02003
4320
6224
6320
1904

.05865
.02003
.07868 is Surface before carbonizing, which multiplied by 171/225 gives .0423 as the area of face of hope after carbonizing.

1.08375
1.05375
54375
76125
57000
10875
1.18265625
1.18306225
.06375
1.05375
1.05375
52875
74025
52875
10575
1.18306225
.07868
15736
7868
225) 9.2625 (.04
900
1320
1125
1950
1800
150

43°22'
38°16'
93°16'
88°44'
93°16'
43°22'
38°16'
76°38'
43°22'
46°38'

1.385
.777
9776
13776
97716
1.009076

1.385
1.009
1379

.9151
.9009
.82347900

.9151
.82346
.09715
.731
.822
1694
150
47
1.156 13
78 91

.6867
1.3836
41336
41336
20601
6867
.7796

.17
.2585 = .731
60 : 1

.731
60

.731) 160 (.20
1462
1200

312

Thickness ~~.00477~~

Thickness before carbonizing .0065

1.631
1.555
3.219
.00349
28.971
12.872
9657
.011234931

.054).011234931(.207
.054
501 11234
224

1.509
1.640
3.173
.00349
28.377
12.612
5659
.054).01168397(.207
54
503
12.2
47

1.363
1.551
2.914
.00349
26.996
11.776
5832
.054).01.7756(.190
54
7
4.7
4.5

1.121
.6615
605
726
225).7545(.00349
675
3.0
3.25
3.20
.1.25
.7.50

1.150
1.496
2.094
.00349
23.346
12.276
5782
.054).0.9.5306(.165
54
3.6
3.6
9.3
5.6
2.5

1.251
.7735
2.256
.00349
20.304
9.024
6768
.054).00873456(.145
54
3.2.7
2.6
3.73
2.0
434

1.169
.785
1.954
.00349
17613
7828
5871
.054).0065293(.121
54
1.1
1.05
.349
3.2
2.5

1.125
.749
1.874
.00349
16821
7476
5607
.054).0065281(.121
54
1
1.0
.72

1.594
1.535
3.129
.00349
28332
12.528
9494
.054).0102856.52(.203
0 54
7.6
1.6
24

1.551
1.363
2.914
.00349
26.996
11.776
5832
.054).0163756(.190
54
7
4.7
4.5
2

1.444
1.510
2.954

1.394
1.531
2.925
.00349
26325
11700
5725
.054).0102852.5(.189
54
6.0
4.5
3.8
4.6
22

1.355
1.551
2.1569
.349
23721
10276
7707
.054).0.8656(.171
54
3.6
3.6
3.2.5
3.0.5

1,250
983
2,213
349
19917
88852
6639
54) 79237 (143
54
232
216
163
162
1,119
1806
1,925
349
17325
7700
5775
54) 67125 (124
54
135
108
238
216
22
1,075
775
1,850
349
16425
7300
5475
54) 63925 (118
54
99
54
45
1,250
349
10125
4500
3375
054) 392625 (727
378 ×
1868
1890
3528
378
1,169
349
10521
4676
3507
54) 407891 (755
378 ×
299
270
29
1,281
349
11529
5124
3843
54) 447069 (82
432 ×
150
108
426
1,444
349
12996
5776
5332
54) 503956 (93
486 ×
176
162
15
1,581
349
14229
6324
4743
54) 551769 (102
54 ×
117
1644
349
14796
6576
4932
54) 573554 (106
54 ×
337
324
13
1,631
348
14679
6524
4893
54) 568932 (105
54 ×
292
270
22
1,354
00349
13936
6216
4662
054) 542296 (100
54 ×
00
22
1394
349
12546
5576
4182
54) 486506 (90
486 ×
20
1,181
349
10629
4724
3543
54) 412169 (76
378 ×
341
324
963
349
8667
3852
2889
54) 336087 (62
324 ×
120
108
12
806
349
7254
3224
2418
54) 281294 (52
270 ×
11
108
3
1350
349
6300
3500
2800
2500
300
54) 261750 (48
216 ×
450
432
18

6366
1121
6366
63732
6366
6366
713.6286

1204
6366
7224
7224
3612
7224
7664664

1126
6366
6756
5756
3378
6756
7168118

1205
6350
7248
7248
3624
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7690128

1146
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6876
3438
6876
7295436

1203
6350
7218
7218
3609
7218
7658298

1168
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3504
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7435488

6366
1189
57294
50928
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1190
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7575540

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1166
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38196
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1143
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25464
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6366
7276338

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1124
25464
12732
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6366
7155384

6366
1118
50928
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6366
7117188

42.5
3.5
2125
1275
3825
422.875

13.35
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1335
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413.85

41.5
2.075
2075
2075
2075
27.9.75

35.4
2.65
70
92.4
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405.70
413.85
422.875
1244.825

31.5
66.5
1575
1890
146.475

2439.65
275.975
146.475
3.61
141
3369.200

1.56

1.28
.95
576.1
1.5
148.00

1245
71
256

3369.2
124.45
2212.54

+2

.9550
.00348
85550
3500
2850
.0423) 00331550 (.7854
2961 ×
3595
3384
1710

.910
5

.9615
348
86485
3460
2895
423) 3367815 (796
2961 ×
0685
3507
2581
2581

1.0015
348
90135
30045
423) 3107745 (5.29
3384 ×
1234
846
3885

1015
348
91355
4060
30445
423) 3294235 (8.3
3384 ×
1583
1269
3775

.9551
348
55229
3924
2943
423) 3423668 (.80
3384 ×
3949

348
920
6980
3141
423) 3276980 (7.75
3384 ×
2985
2115
3830

8235
348
74235
3300
2475
423) 2875925 (6.8
2538 ×
3472
2538

348
710
13940
2448
423) 2958960 (6.61
2538 ×
4196

348
710
34.90
2443
423) 2477908 (5.8
2115 ×
3629
3384
2450

635
348
5715
2540
1305
423) 2261515 (5.2
2115 ×
1014
846
1655

598
348
5382
2392
1794
423) 2087072 (4.9
1692 ×
3950
3807
1432

5.85
348
5292
2352
1764
423) 2095212 (4.95
1692 ×
3601
3384
2172
2115

950
560
532000
348
63 3900
60840
4530
423) 5367900 (12.95
423 ×
1039
846
1939
1692
2470

950
560
532000
348
13225
6100
4275
423) 5522225 (13.
423 ×
1292
846
2462
2115
347 5

950
605
155-5
349
13995
6220
4665
423)54269 (128
423
1196
846
3509
3384
1255

965
675
1440
349
14760
6560
4920
423)17236 (135
423
1383
1269
2246
2115
1310

1005
285
1720
349
1371
716
537
423)4247 (147
423
2017
1692
3255
2961
290

1015
820
1885
349
16965
7540
15555
423)65785 (155
423
2348
2115
2336
2115
2215

981
730
1911
349
17199
7644
5733
423)69339 (157
423
2439
2115
3243
2961
2829

915
820
1575
349
16575
7500
15825
423)63437 (150
423
2037
1692
3457
2961
1987
1692

945
825
1770
349
15993
7608
1311
423)61773 (146
423
1897
1692
2553

710
700
1610
349
1449
644
483
423)16189 (132
423
1388
1269
1199
1056
143
423)1435 (
3302
3172
1342
423)1342 (
1269
73
2

890
635
1525
349
13725
6100
1425
423)12225 (125
423
1802
1692
2533
2115
4182
423)4182 (
423
3759
423
3336
423
3312
423)3312 (
3174
138
2

2nd

1125
6326
67.50
67.50
3375
67.50
7161.750

1156
6366
5936
6936
3468
6936
7359.096

1126
6366
6756
6756
3375
6756
7168.11

1125
6326
6948
5346
2674
6948
7371.82

1125
6326
6768
6768
3384
6768
7180.53

1125
6326
6930
6930
3465
6930
7352.730

1125
6326
6810
6810
3405
6810
7225.4

1156
6366
6855
6855
3427
6855
7285.6

1156
6366
5936
6936
3468
6936
7359.096

1125
6326
6948
5346
2674
6948
7371.82

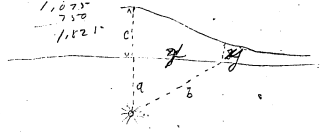
1125
6326
6930
6930
3465
6930
7352.730

1125
6326
6576
6576
3288
6576
7976.76

1125
6326
6576
6576
3288
6576
7976.76

1125
6326
6576
6576
3288
6576
7976.76

1,0725
7,50
1,821



$b^2 = a^2 + x^2$

$y : c :: a^2 : a^2 + x^2$

$y = \frac{a^2 c}{a^2 + x^2}$

$a^2 + y^2$

$a^2 + y^2 = c^2$

$a^2 dy + 2y\,x\,dx + x^2 dy = 0$

$dA = y\,dx$

$a^2 dy + 2x\,dA + x^2 dy = 0$

$2x\,dA = -(a^2 + x^2)\,dy$

$dA = -\frac{(a^2 + x^2)}{2x}\,dy$

$dA = \left(\frac{a^2 c}{2y\,x^2}\right)dx = \frac{d}{dx}\left(\frac{c\,a^2 x}{a^2 + x^2}\right) = 0$

$c\,(d, \ldots)$

1,5358697
1,5333430
2,0867023 27
1,5 y 64
16
9270
2,7 0
2,7 0

$20^0 y^2$
$125^{\ldots}$

10 / 38,28
3,828

75°22
60
45 22''
360
21600

3,1416
10
31,4160

62,8832
4 1 = 2
12,5664
12,5664
31,4160
25,1328
28,4 1,2 6,30 y (13,15
216
16
2,8 1
8
3,2
5,6
6

2,832
13,7

1,3,15
6
7,8 9 0
7,3 5
2,1 6 4 0

$dV = \pi x^2 dy$

$\cancel{dV = \pi a^2 (c - y)\,dy}$

$a^2 y + x^2 y = a^2 c$

$\cancel{x^2 y = a^2 c - a^2 y}$

$\cancel{x^2 = \frac{a^2 c - a^2 y}{y}}$

$dV = \pi a^2 \left(\frac{c\,dy}{y} = \frac{c}{y}\,dy\right).$

$\cancel{V = \pi a^2 c}$

$a^2 dy + 2x\,dx\,y + x^2 dy = 0$

$a^2 dy + 2x\,dx\,y + \frac{dV}{\pi} = 0$

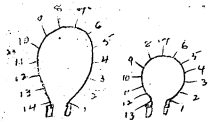
769) 16 0 0 (21
15 3
6 1 0

Menlo Park Notebook #67 [N-80-01-02.1]

This notebook was used between January 2 and January 16, 1880 to keep a record of lamps burning at the Menlo Park laboratory complex. Most of the entries were started by Charles Batchelor when the lamps first began burning. A daily record was then kept by either Batchelor or by another laboratory assistant, probably Francis Jehl. Some of the entries are by Edison, including a few extensive notes near the middle of the book. Toward the end of the book is an index to the lamps. The label on the front cover is marked "Lamps Burning," "Jehl," and "Jan. 2/1880." The book contains 132 numbered pages followed by 10 unnumbered pages. The pagination is irregular. With a few exceptions, only the right-hand pages are numbered.

Missing page number: 50.

No 67



LIBRARY OF THE

BOARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

GENERAL REPORTS
Bowd St. N.Y.C.
May 1, 1896

Record of Lamps.

No 142. Resistance 150 ohms { 1850 Jan 2nd / 12 noon

has burnt at least 200 hours

{ This lamp is hung on the two main
{ wires over the pumps

Jany 5 measured resistance no change

hour	Jan 2nd	
200		
19-30	3	
9-58	4	
20-50	5	
3-47	5	
10-26	6	
12-15	7	
22-00	8	
9-00	9	till 5 o'clock
	360 Total	

Jan	9	6-50
Jan	10	19-15
Jan	11	7-00
Jan	12	11-00 Total 404.15 after noon

Bissler Jan. 13. 2 AM

No 159 Hung on leading one pump

Resist. 153 ohms — } Jan 2 1900 noon
Has burnt 200 hours

Jany 5 measured resistance No change

		hour
Jan 2.	—	200 —
" 3	—	19.30
4	—	9.55
5	—	21.50
5	—	5.47
6	—	20.26
7	—	12.15
8	—	22.00
9	—	9.00

Total time 860.12 Jany 1/12

Jany 8: resistance same

9 — 65-0
10 — 19-15
11 — 7-00
12 — 11-00 Total 404.05 up to 12 o'clock
12 9.-30
15 11-00 " 424.35 " 12 noon "
15 41-30
14 22-30
15 11-30 " 480.30 "

No. 189 ~~149~~ – Chandelier in top room
Marent pulmpe

Resist. 149 } Jan 2 1885. Noon.
Has run 13 hours

	hrs
Jan 2	13
3.	19 - 30
4	9 - 55
5	20. - 50
5	3. - 47
6	20. 26
7	12. 15 -
8	22. 00
9	9. 00
9	6. 80
10	19. 15 -
11	7. 00
12	11. 00

Total time Turned ~~140.15~~ 173.12
W. 5.00 P.M.

" " " 217.17 aft 7 noon

Bristol at 8.40

No ~~[illegible]~~ 275 Second Chandelier top room 4

Resist. 142.

Jan 2 1880
12 noon

Has run 13 hours

Has run since 8

21 Total running

Broke by vibration in taking off and on ¼ in above centre (Edison saw this)
Jan 2 1880.
8 p m

Edison says: not quite sure about this

No ~~255~~ Second Chandelier top room

Recist ~~200~~

Has run 13 hours

Jan 2 1880
12 noon

Jan 3	19-30	
4	9-55	
5	20-50	
6	3-47	
7	20.26	
8	12.15	
9	22.00	Total time runned 173.12
9	9.00	at 5:00 P.M.
9	6.50	
10	19.15	
11	7.00	
12	11.00 "	" " 217.17. up to 12 m
12	9.30	
13	11.00 "	" " 237.47 " " "
13	11-30	
14	22-30	
15	11.30 "	" " 29[illegible].17 " "

Brown

223 Third Chandelier top room 6

Reis 140 } Jan 2 1880 noon

Burnt 13 hours.

Jan 13	19 - 30
4	9 - 58
5	20 - 50
5	3 - 47
6	20 . 26
7	12 . 15
8	22 . 00
9	9 . 00
9	6 . 50
10	19 . 15
11	7 . 00
12	11 . 00
12	9 . 30
13	19 . 00
13	11 . 30
14	22 - 30
15	11 - 30

Total time burned ~~148~~ 143.12 at 500 P.M.

" " 137.17 ~~4~~ noon

" " 207.47 " "

" " 262.17 " "

Burlett

Burlett

193 Chandelier near organ 7

Burnt 154 } Jan 2 1880
noon

Burnt 13 hours
Jan 3 – 19·30
4 – 9·58
5 – 20·50
5 – 3·47

Taken out on Jan 7 1880
to put in street lamp
replaced by 376 experiment

162. Chandelier near organ

Recd 147 } Jan 2 1880 -noon

Burnt 13 hours
Jan 3 19.30
4 9.55
5 21.50
5 3.47

Taken out on Jan. 9 1880 replaced by 375 experiment- bend on end of tip Taken to Annabel's orders

A- cost- 102.00 Total Brought- up for [illegible] light

164. Third Chandelier top room South side?

Rest 136
Burnt 13 hours } Jan 2 1880
noon

Saw this burst at 3 pm Jan 2
Inside glass broke

Total length of burning
15 hours.

204 Flammers bench

Resist
Burning 13 hours } Jan 2 1880
noon

Jan 2 1880 Taken out by Edison and
5 pm given Upton to make test for
rupture
Total burning 16 hours

203 Flammer's bench.

142 Burst } Jan 2 1880
Burnt 5½ hours } noon

After burning a total of 17½ hours it broke

155 Over Carman's desk Office 12

Resist 126 ohm } Jan 2 1880
Burnt 50 hours } noon

Jan 3.	19-30	
4	9-50	
5	20-50	
5	3-47	
6	20-26	
7	12-15	
8	22-00	
9	9-00	Total time burned 260 hrs up to 5:00
9	6-50	
10	19-15	
11	7-00	
12	11-00 Tu	" " 204.05 - aft to noon
12	9-30	
12	11-30 "	" " 224.35 " " "
13	11-30 "	" "
14	22-30 "	" "
15	11-30 "	" " 280.05 " "

201. Ore Carmans desk (Office) 13

Resist 147 } Jan 2 1890
Burnt 50 hours } Noon

Jan 3	19.30	
4	9.55	
5	21.00	
5	8.47	
6	20.26	
7	12.15	
8	22.00	
9	9.00	Total time burned ~~200~~ 260 hours up to 1.00 P.M.
9	6.00	
10	19.15	
11	7.00	
12	11.00	" " " 204.00 up to noon
12	9.30	
13	11.00	" " " 224.30 " "
13	11.30	
14	22.30	
15	11.30	" " " 280.00 " "

164 Office Chandelier near door 14.

Receipt 182 Jan 2 1880
Noon

Burnt 50 hours.

Jan 3	19-80	
4	9.50	
5	20.50	
5	3.47	
6	20.36	
7	12.15	
8	22.00	Total time burned ~~200~~ 160 hrs up to 1 PM
9	9.00	
9	6.50	
10	19.15	
11	1.00	
12	20.00	" " 204.05 up to noon
13	22.30	
14	22.80	" " 224.03 " "
15	11.90	" " Correct Total 322.13 " "

142 Chandelier over Griffe desk

Burnt 135 } Jan 2 1880
Burnt 58 hours } Noon

Jan 3	19-31
4	9-58
5	21.50
5	3-47
6	20-26
7	12-15
8	22-00
9	9-~~00~~
9	6.50
10	19.15
11	7.00
12	11.00 " "
12	11.38
13	22.36
14	11.30 "

True time burned ~~200~~ 160 hours up to 5 P.M.

204-15 - up to noon

25-942 - - -

184 Hand lamp Griffin desk

Rissel 145 } Jan 2 1880
Burnt 50 hours } noon

Taken Jan. 3 1880 Taken to Paris

Put back on same day

Jan 2.	50 hours
3	19.30
4	9.55
5	20.50
5	3.47

Taken on Jan 6 1880

and put under water in

Extracting 332 pw in its place 94 Page

158 Chandelier Office top room near closet

Jan 2 1880 noon

Recd 137

Burnt 50 hours

Jan 3	19.30	
4	9.55	
5	20.50	
5	3.47	
6	20.26	
7	12.15	
8	22.00	Total time burned ~~100~~ 160 hours
9	9.00	
9	6.50	
10	19.15	
11	7.00	
11	11.00 " "	204.05 aft 5 noon
12	9.30	
13	11.00 " "	224.35 " "
13	11.30	
14	22.30	
15	11.30 " "	280.05 " "

198 Chandelier near closet
Office top room

Jan 2. 1880
noon

Burnt 114
Burnt 50 hours

Jan 3.	19.30	
4	9.58	
5	20.50	
5	3.47	
6	20.26	
7	12.15	
8	22.00	
9	9.00	Total time burned ~~200~~ 160 ~~12~~ 45 19th
9	6.50	
10	19.15	
11	7.00	
12	11.00	" " " 204.05 sixth noon
12	9.30	
13	11.00	" " " 224.05 " "
13	11.30	
14	22.30	
15	11.50	" " " 279.35 " "

Blistered this evening at 4.00

Gas blisted

270 Hand lamp at Regulator Table
Bottom room

Keeis 140 } Jan. 2 1880
Burnt 70 hours } noon

Jan 3	19.30
4	9.58
5	20.58
5	3.47
6	20.26
7	12.15
8	22.00
9	9.00
9	6.50
10	19.15
11	7.00
12	11.00 "
12	9.30 "
13	11.00 "
13	11.30
14	12.30
15	11.30 "

Total time burned ~~[illegible]~~ 185.12 hours up to 5 o'clock

" " 229.17 up to noon

" " 249.47 " " ✓

" " ~~204~~ 17 " " "

143 Second bench right hand side machine shop 20

Resist 136 } Jan 2 1880
Burnt 10 hours } noon

Broke Jan 4 1880 6 P.M.
Total hours burnt - 32 h
Carbon broke by vibration

186 In dynamo room on side door

Recd. 155 } Jan 2 1880

Burnt about ~~150~~ 150 hours }

Jan 3 19.20

4 9 55

5 20 50

5 3 47

Burned in engine room

total - 204-17 omin - Total

Glass tube

211 Lam in Dynamo room
on Engine room door

Resis 159 } Jan 2 1880
Burnt about 150 hours } noon

Back on the night of Jan 2 1880

Total burning time 170 hours

Burned in places:

No 147 Street Lamp right hand of Office door

Rec 145
Burnt 70 hours } Jan 2 1880 noon

Bucked 1 a.m.
13 hours

Total. 83

Bursted Jan 2/1880
6.30

Carbon ok twas the glass, this Lamp was used a long while before putting on Street its been up to 8 gas jets.

No. 236 Sheet Camp left hand
Office door No 7

Peais 130
Burnt 70 hours
Jan 2 1880
noon

Jan 3 – 19.30
4 – 9.58
5 – 20.50
6 – 3.47

Glass tube after burning 5.2.5.5.

218 Street lamp by Jordans

Resist 15Ω } Jan 2 1880
Burnt 45 hours } Noon

Broke Jan 2 1880 5 PM
Total time burning 50 hours

248 Mr Jordans drying table 26

Rec'd 135 } Jan 2 1880
Burnt 35 hours } Moon

Broke on Jan 8/1880 total
time burned 4 5 hours

Furnace cake at least 6

222 Mr Jordan's Timing table 27

Reas 147 } Jan 2 1886
Burnt 35 hours } worn

12 hours Jan 2.

47 total running

Busted at top of Coop. oxydized in spots

619
21
640

119
12
631

662
19
681

77
32
109

257 Mr Jordans parlor

Jan 2 1880
Wood

Reis 160
Burnt 35 hours
Jan 3 19.20
4 9.55
5 20.50
5 3.47

Total hours 77.12 –

Bethe dl – 8.40

Dont see crack but see with glass
bubble up in glass stretching a platinum

*

242 Mr Jordans parlor

Jan 2 1880
noon

Reis 160
Burnt 35 hours

Jan 3	19.30	
4	9.58	
5	20.50	
5	3.47	
6	20.26	
7	12.15	
8	22.00	
9	9.00	Total time burned 195.12 hfs to 5 AM.
9	6.50	
10	19.15	
11	7.00	
12	11.00	239.17 hfs to noon
12	9.30	
13	10.00	259.57

52
44
96

206 Street Lamp Corner ✓ 30
Edison railings

Resis 142
Burnt 30 hours
Burnt 2 am.
14 hours
Total 44

Jan 2 1880
2 noon

Large crack in glass
where sealed off

108 Street lamp at Collins gate

Reis 141
Burnt 35 hours
One of the old steel clamps

Jan 2 1880
Noon

Jan 2	25
3	19.50
4	9.55
5	25.50
6	3.47
6	20.26
7	12.15
8	22.00
9	9.00
9	6.50
10	14.15
11	7.00
12	11.00 " "
12	9.30
13	11.00 " "
13	11.50
14	22.30
15	11.30 " "

No 3

Total time burned 195.12 up to 5 PM.

" 239.17 up to noon

" 259.37 " " "

" 315.07 " " "

176 Edison's Parlor afternoon
~~Street Camp~~

Reist 167 } Jan 2 1880
noon

Burnt. 60 hours
Jan 3 19.20
4 9.55
5 29.56
6 3.47
114.5 total

Taken out 4 9 cannon (good) - Jan 6 9 AM
Put in ~~Street~~ Camp in front of Edison's door
at 3. P.M. Jan 6.

Burnt previous 114.05 hours
Jan 6th from 3 pm to

for Benjamin J. Jones

555 – Res 142

550 132

556 142 gms.

554 145

553 137

549 135 –

Where 549 came from

Cannot

Think

207 Edison parlor 33

Res 127 } Jan 2 1880
Burnt 60 hours } good

Jan 3 .19 34
4 .2 57
5 .24 57
6 .3 47 total
114 .5

Jan 6 4.9 a.m taken off by Geo Carman
all right – looks kind of smoky on glass

210 Edisons parlor ✓

Resis 127 } Jan 3 1880
Burns 60 hours } noon

Broiled Jan 3 1880 Total No.

Time burned 65 –

Rich formed with clamps

63 Edisons parlor 35

Resis 135 } Jan 2 1880
Burnt 60 hours } noon —

Started Jan 3 1880 [illegible]

Amps Inner 74 —

Carbon Broke

196 Edison parlor ✓ 36

Resis 117
Burnt 6 hours

Jan 2 1880
noon

Found busted
Inside glass broke

194 Edisons parlor

Jan 2 1880

121 Resis

Burnt 60 hours

Jan 3 19 30

4 9 35

5 21 37

5 3 27

114.05 total

Taken out by Geo Carman (good) Jan 6 9 AM

153 Street Camp Corner of Upton House

Keers 132

Burnt 90 hrs

Jan 3	19	.30
4	9	.58
5	20	.50
6	3	.47
6	20	.26
7	12	.15
8	22	.00
9	9	.00
9	6	.50
10	19	.15
11	7	.00
12	11	.00
12	9	.30
13	11	.00
13	11	.30
14	12	.30
15	11	.30

Jan 2 1880

Total time ~~[illegible]~~ 207-36
7p to 5-PM.

231.41 Upton

272.41

34-7

5 23 11

235 Street Camp Twp of Plains
Sight Hours

39

Rais

Burnt 40.
Jan 3 19.30
4 9.55
5 21.57
6 [illegible]
7 [illegible]
8 [illegible]
9 [illegible]
10 [illegible]
11 [illegible]
12 [illegible]

Jan 2 noon

Total time burned
70.18

Carson Foster
~~Total time burned 20.36~~
~~Up to 5 P.M.~~

~~21.41 at 6 noon~~

62
50
112

229 Shed lamp top depot slaw -40
left hand

Revs. 145
Burnt 45 horse

Jan — 1880.
Arson

Booted by
at 5.40 P.M. Total time insensible 62
hrs 10

Carbon broke at clamp 1

224 Upton feeder (Middle) 41

Pears 109
Burnt 40 hours
~~Jan 5 19 30~~
~~4 9.50~~
~~5 20.50~~
~~5 3.47~~
6
7
8
9

Jan 2 1880

	noon	h. m
Jan	2	2.00
"	3	2.00
"	4	2.00
"	5	2.00
"	6	2.00
"	7	2.00
"	8	2.00
"	9	2.00
"	10	2.00
"	11	2.00
"	12	2.00
"	12	
"	13	
"	14	
"	15	
"	16	

average 3.30 per hyl

78 "
80 hrs

170 Gipsolite Parlor Burner by door

Rec 157 — Jan 2 1880

Burned 40 hours

Jan 2	2 00	
" 3	2 00	
" 4	2 00	
" 5	2 00	
" 6	2 00	
" 7	2 00	
" 8	2 00	Total time burned 68 hours
" 9	2 00	
" 10	2 00	
" 11	2 00	45 hours
" 12	2 00	" " " 62 "
" 13	2 00	" " " 64 "
" 14	2 00	
" 15	2 00	aver. 8.86 per night 8

168 Optima Pontes fur corner 168

Rec 147 } Jan 2 1880
Fund 40 Jones } 0:00

Jan. 2	2.00	
" 3	2.00	
" 4	2.00	
" 5	2.00	
" 6	2.00	
" 7	2.00	
" 8	2.00	
" 9	2:00	Total time burned 58 hours
" 10	2.00	" " "
" 11	2.00	" " "
" 12	2.00	" " " of the room 2 " 8 "
" 13	2.00	
" 14	2.00	
" 15	2.00	one 9.80 per night 80

181 Optima Chile

No. 152

Finished 40 Lines

Jan. 2 — 5.30 Dim Light

Jan 3 — 19.30

" 4 — 8.90

" 5 — 12.07

" 6 — 20.26

" 7 — 12.15

" 8 — 22.00

" 9 9.00 Total time burned ~~[illegible]~~ 207.36 Hrs 5 P.M.

" 9 6.50

" 10 19.15

" 11 7.00

" 12 11.00 " " " 251.41 yesterday

" 12 9.30

" 13 11.00 " " " 272.11 " "

Flemming

300 Oca ~~Cuffitto~~ deck in Lacing

Ros. 139 Jan 2 1880

Burned 1 hour Noon

Cotton broke in another place

Total running time 8 hours eight hours

OM Sup 53

204
.50

301 Right-hand of 4th chandelier connecting Jima organ

Rec tape heating 22-9 January 30 10

Commenced burning @ 9.45 on Jan. 2 1880

put in by Edyson

Jan 2	~~[illegible]~~	2.15	Refer to page
3		19.20	
4	—	9.55	52
5		20.50	
5		3.47	Edyson

Burnett

-1 total 56.20

303 On third Chandelier counting from organ

Res before hunting 265 — | Jan 2 1850
Rest in By Cotgrave | 9.45 - P.M.
— Broke in Amst — | Commenced hunting
1 hour time

Refer to page 49

Bursted

244 –

Hung on wires – 18 hours

heated $\frac{1}{4}$ in above regular

place,

49—

No 303. burstled in glass after 1 hour.

Total 1 hour —

On breaking the glass the small round part where the wire passed through was coll. with a white buckskin like substance apparently showing that it was not heat.

Edison

No Lamp 311 - Same exactly as number 810 -

No 301,

Burned 1 hour, burnt carbon near top almost in centre. It was high resistance lamp Badly oxidized. It was bright at top & only yellow at bottom.

215
48
263

300 Con Charles Frankenbach in Laboratory

Rec. 145 } Commenced running
Fuum 30 } at 9.50 AM Jan 2/1880

Broke after running 48 ions
carbon broke —

109
13/3
242

161 Cin table in Laboratory with
Blade &c

hrs 147
Burnt 26 hours

Jan 3 1880
9.30 AM

Jan 3.	18.00
4	9.58
5	20.00
5	3.47
6	20.26
7	12.15
8	22.00
9.	9.00

Total time burned up to 5 P.M. ~~[illegible]~~ 133 hrs

~~Burned Saturday evening at 9.00 [illegible]~~

~~Total burning time 257 hrs~~

put in Second Chamber
from Roofs 257 Jany

In telephone room on table

put in Jan 3rd 1880 9.30 AM

Jan 3 —	10 —	
4	9 54	
5	20.57	
5	3 47	

Taken to give put in chandelier

Boston afternoon

Office

197 — Dr Chandler were down left-hand side

Rec. 145 Commenced mowing at 12 o'clock noon Jan. 3/1880

Jan 3.	12.	
4	9.38	
5	20.50	
5	3.47	
6	20.26	
7	12.15	
8	22.00	110.06
9	9.00 Total number here	~~[illegible]~~ 21-5 [illegible]
9	6.00	
10	19.15	
11	7.00	
12	11.00	154.11 7 mm
12	9.50	
13	11.00	174.61

9 1 3

Lap room (Experiment room) 37

B07 .2 chronicles from organ right-hand side north

242 Rio.

Commencing for ning

Jan 3 1880

Jan 3 12.
4 9.50
5 20.50
5 3.47
6 20.26
7 12.15
8 22.00
9 4.00 Total number of hours 110.10 up to
9 6.50
10 19.15
11 9.00
12 11.00 " " 154.11 up to noon
12 9.00
13 11.00 " " 174.31 " "

Taken to lineness from time

306 Steel Camp. 5-8

306 Right-hand lamp in front of office south

187 Rs Commenced burning Jan 8 4.50 PM

Carbon a little overridgyed

Taken off Reduce burner — as

dirty Total Time burned 28.10

295 Tried in Chamberlain 59

Res 137 Jan 3 1880

Commenced Noon

Burke immediately glass thin

Inside glass cracked also piece flew out

310 Batchelors commenced 60
Comp
R. 140
Commence training } January 3 1885
Left point Thursday PM
Busted } Jan 4 1885
Total hours worked 6 hours

42
261
303

312 Bach Chimdelem from organ 61

Rec. 142 Commenced Jan. 3/1880
8.40 P.M.

Running
~~Up~~ month
Jan 3 – 8.20
4 9.58
5 21.58
5 3 47 42 hours

Buried at – 8.40 P.M. E. C.

Carbon Broke at dump apparently by
jar in putting in

I think this was broke by jar given
when someone tried to put it in

436 Rod 67

Notice

Pull on 3 chandelier

Jams open into Rod

Trimmer 4.10 P.M.

249
81
330

214 Commenced running at -

400

Res. 175 — | Jan 3d 1880
3 P.M.

from left hand Chandelier
~~north~~ left hand side
NORTH

Jan 3.	9 —
4	9.58
5	20.50
6	3.47
7	20.26
8	10.15 —
9	22.00
9	9.00 Tube trimmer broke at 5 P.M.
10	6.50
11	19.15 —
12	7.00
	11.00 — 249.00 —

105

Bratten at — 9. ~~on~~ the 15th

240 Lamp on corner plank walk 3rd from office —
to Repeat —

No. 124 Commenced burning at — Jan. 3. 1880 9.30 P.M.

Removed to lamp post on corner of Laboratory yard.

Jan 3	8.30
4	9.55
5	20.50
5	3.47
6	20.26
7	12.15
8	22.00
9	7.00

Total hrs burned ~~163~~ 29 up to 1 p.m.

Glass that leads up wires cracked down to inside bulb and I think lost vacuum

304 Hammer's 1c each

Ro. 141

Commenced Burning
hours
5
9.58 Jan 3
4

Jan. 3 1880
X after P.M.

Taken down to Edyson's one night.
Permanent

189
268
457

264 First lamp over pumpe 2

Laboratory
Ro —
Commenced burning } Jan. 4 1880 7.40. P.M.

Jan 4	4 . 20	
5	20 . 50	
5	3 47	
6	20 . 24	
7	10 . 15	
8	22 . 00	
9	9 . 00	Total time burner ~~burnt~~ 90.36 s.P.M.
9	6 . 50	
10	19 . 15	
11	7 . 00	
12	11 . 00	134.41 up to noon
12	9 . 30	
13	11 . 00	155 . 11
14	22 . 30	189 . 4

Bursted the morning of the 15th

134

Dump masher turned 24 minutes

✓ 66

2 34 hour in water laboratory

Rec. } Jan. 4 1880

Time burning 114 hours } 7.30

Bursted at 8 o'clock Jan 5 1880 A.M. Total time burned 134 hours

Ste 263 In front room in Cargo
Res 147 Jan. 3 1880
Burned 4½ hours 7.40 P.M.

Jan 3	4.40	
" 4	8.90	
" 5	12.07	
" 6	20.26	
" 7	20.15	
" 8	22.00	
" 9	8.00	Total time burned 93.48 up to 5 P.M.
" 9	6.30	
" 10	19.45	
" 11	7.00	
" 12	11.00	127.50 up to noon
" 12	9.00	
" 13	14.00	150.25

Revised
Larger cistern before air 7 Pm.

17. 8.00
18 2.00
19. 8.00
1.800

299 Jn Cringe finish room

Jan 3 1880
7.30 P.M.

Rec.

Time burned 4.30

Jan. 3 4.30
" 4 8.90
" 5 12.07
" 6 20.26
" 7 12.15
" 8 22.00
" 9 9.00 Total time burned 93.48 at 1 P.M.
" 9 6.50
" 10 19.15
" 11 7.00
" 12 11.00 " " 131.58
" 12 9.30
" 13 11.00 " " 152.23
" 13 11.30
" 14 22.30
" 15 21.30 " " 207 3.6

Bunted

Not entered

323

~~323~~ on Steel Camp Face 69

Ro

Commenced at 10 P.M. | Jan. 4 1860 10 P.M.

On table in Laboratory.

Broken at 11.43 running time 1.40 h m

Laboratory table

104 On Base of steel-Clamp

70

Rio. 126

Jan 4 1880

Burned 50 hours

10. P.M.

On Table in Laboratory

Jan 4	52 h		
5	20	50	
6	3	47	

Bristol when lights were put-
al 1 Mean Total hours burned 76.37

Carrum tube Badly oxydized

Old clamp
Inside glass enameled
glass tube on wire leading to

328 Flannery's Bench
Laboratory
Rio 135

Jan. 4 1880

Commenced burning at 11.45

Jan 4	0	15
5	20	50
5	3	47

Carbon started after burning 28 hours in same place Jan 6/1880

015 – from Indiana during term

Rec 2.30

Commenced burning at 9.00 AM

Jan 5. 1880

Jan 5 –	13.
5	3.47
6	20.20
7	18.15
8	22.00
9	9.00
9	6.50
10	19.15
11	2.00
12	9.00
13	11.00

Total time burning 80.28 hrs

Cook Lantern " 124.33 hrs burning

" 145.23 ...

80 hours

316 Thos. Jardine burning kerm

Re 185-

Commenced burning 9.00 AM } Jan 5 - 1880

Jan 5	13.00
" 5	3.47
" 6	20.26
" 7	12.15
" 8	22.00
" 9	9.00 Total hours burned 80.28
" 9	6.50 after 5 P.M.
" 10	19.15
" 11	7.00
" 12	11.00 " " " 121.33 afternoon
" 12	9.00
" 13	11.00 " " " 146.03 " "

Burned in P.M. Clock Gaton

✓ 74

3/7 Machine Shop on door to Engine room

Res 144

Commenced running at 9.00 AM

Jan 5 13 hours

5 3.47

Jan 5 1880

Broke on Jan. 5 1880

Total time runner 16.47 hours

318 Lamp post between
office and Laboratory
Bur. 152 Jan: 5-1880
Commer training 10 A.M.

Jan 5 12 hours
5 3.47

Buried Jan. 7 1880 at 9 A.M.
This time burned 25 hours

X

Badly oxygenized Carbon ashes C.C.

No 313 on dump post between Laboratory and Shop

Res 155 — | June 5 1880

Commenced | 11.20 AM

Running at —

Jan/5	10.40	
5	3.47	
6	20.26	
7	12.15	
8	22.00	
9	9.00	Total running time 77.08 ofes-pth.
9	6.50	
10	19.15	
11	7.00	
12	11.00	" " 141.15 up 2 mon.
12	9.00	
13	11.00	" " 141.43 " "
14	11.30	
14	12.30	
15	11.30	" 198.13 " "

Sheet Camp

334 ~~XX~~ Opposite Tomorrallo 77

Stable

Fire 145 –

Commenced Burning at –

Jan 5 – 1885

1 P.M.

Jan 5 –	9 hours	
5	3.47	
6	20.26	
7	12.15 –	
8	22.00	
9	9.00	Total burning time 66.28
9	6 50	5 P.M.
10	14.15 –	
11	7.00	
12	11.00 "	" -111.33
12	9.00	
13	10.00 "	" -132.88
13	11.20	
14	22.30	
15 –	11.30 "	" -187.83

Sheet Camp

331 Corner opposite Bertheters mine

Rec. 145 | Jan 5 1880

Commenced | 11.40 A.M.

running at—

Jan 5	12.20	running
5	3.47	—
6	20.26	
7	10.15	
8	22.00	
9	9.00	Total 77.48 hours up to 5 PM
9	6.50	
10	19.15	
11	1.00	
12	11.00	" " 122.58 up to noon
12	9.00	
13	11.00	" " 143.25
13	11.30	
14	22.30	
15	11.30	" " 197.55

325 Depot lamps 19

No 325 — For post on night hours side of stores going to depot

Rec 143 Jan 5, 1885
12 noon.

Jan 5	12 hours running	
5	3.47	
6	20.26	
7	10.15	
8	22.00	
9	9.00	Total time burned ~~[illegible]~~ 77.48 hrs up to 5 PM

Moved from there on Jan 10 take Glass running up wire broken off on top probably lose vacuum this way

+ post between Cabinetry and office

Street lamp on pleasure walk
(in corner) electric from office 80
327 For post in corner of
pleasure walk
Res 150 Jan 5 1889
12 noon.

Jan 5. 12 hours running
5 3.47

Gross for the Total hours 15.47

V. 16 hours

Sheet Camp

81

322 — Department of office

Boston side

Rec'd 15-0 | Jan. 5-1880

Commenced | 11.50 A.M.

Burning at —

Jan 5 | 12.10 burning

5 — 3 47 —

6 20.10

7 10.15

8 22.00 Total time burned 77.48 up to 5-PM

9 9.00

Punctured

Dont see Clack but see bubbles all way up the leading wires

✓ 78 hours

82

329 Dr ships over Billy Knights
Dock-bench
h. 146 | Jan 5. 1880
Commenced
Running at- | 14.30 P.M.

Jan 5th 12:10
Jan 6th 14:40
1:15
Jan 1-30 2:45

Taken out by Batchelor
OK.

Total running time 3 1.05

326 in machine 2/10/0 second
light from door

Res 140

Jan 5-1880

Commenced burning at 11.00 A.M.

Jan 5 13
5 3.47
6 20.16
~~7 15.15~~
~~8 22.00~~
~~9 9.00~~

changed to telephone bench in front of kitchen hutch
Jan 6th 10 AM

Total time burned 3.13

Taken out after 3.13

3.30 Bustle immediately on
~~putting~~ in chandelier
Rev 140 | Jan 5 1840

Inside Glass broke very uneven
thickness.

333 Street lamp

Rec. 137 on Lamp post at the Corner of Lexington ~~[illegible]~~ fence

Commenced | Jan 5-1880

Running at 5.30 p.m.

Jan ~~[illegible]~~ 6.30 hours running

6 20.26

7 12.15

8 22.00

9 9.00 total 70.11 miles up to 1-5 P.M.

9 6.50

10 19.15

11 7.00

12 11.00 = 114.16 up to noon

12 9.00

13 11.00 = 125.46

13 11.30

14 22.30

15 11.30 180.16

382 / Under Water on
Laboratory table
Rio. | Jan 5 1880
Commenced | 5.30
burning at
Jan 5th / 6.30 hours burning
Jan. 6 1880 Removed from water
and put in office on handlight
stand on desk
Bristed Carbon Total time
Burned 50 hours

Edisons Dining room

87

342 In Edisons house 1st

Chandelier from door north side in dining room

Commenced to burn at 1.30 P.M.

Jan 6 1880

Jan. 6	8.20.	
" 7	12.15	
" 8	22.00	
" 9	9.00	The time burned 5-1.5-5 at 5-P.M.
" 9	6.50	
" 10	19.15	
" 11	7.00	
" 12	11.00	96.50 of 5 cent
" 12	9.00	110.00
" 13	11.00	
" 13	11.30	
" 14	22.30	
" 15	11.30	170.00

Edisons Dining Room

336 1 chandelier north side
counting from door south side
In Edisons in dining room
Commenced burning at Jan. 6 1880 at 1.30

Jan 6 8.20 Res. 117
" 7 12.15
" 8 22.00
" 9 49.00 Total time burned 51.35 at 5 P.M.
" 9 6.50
" 10 19.15
11 7.00
12 11.00 " " " 73-40 ohms
12 9.00
13 11.00 " " " 117-10 "
13 11.30
14 22.30
15 11.30 " " " 172.40 "

Edisons Dining room

335 — 2 wd. Chandelier Dn. 89

Edison's house north side in dining room

Commenced burning at — Jan 6 1880 1.30

Jan. 6	8.20	
" 7	12.15	
" 8	22.00	
" 9	9.00	Total time burned 57.35 up to 6th
" 9	6.50	
" 10	19.15	
" 11	7.00	
" 12	11.00	95.40 sum
" 12	9.00	116.10
" 13	11.00	
" 13	11.30	
" 14	22.30	
" 15	11.30	172.40

Edisons Dining room

343 2nd Chandelier Dining room

In Edisons House South side

Per. Jom Smith 1880

1.30 P.M.

Commenced running at—

Jan. 6	8.20		
7	12.15		
8	22.00		
9	9.00	total hours 51.35 hours up to 5 P.M.	
9	6.50		
10	19.15		
11	7.00		
12	11.00		95.40 aft 12 m
12	9.00		
13	11.00		115.10
13	11.30		
14	22.30		
15	41.30		161.40

298. Street Camp in front of Edison's House 91

This was taken from Theis's Hall where it had run 62 hours —

Put on street Camp Jan 6 4pm.

Jan. 6	8. 20		
7	12. 15		
8	22. 00		
9	9. 00	Total time 31.85 hrs after 5 PM	
9	6. 50		
10	19. 15		
11	7. 00		
12	11. 00	"	95.40 mean
12	19.30		
13	11 00	"	110.10 "
13	11.30		
14	22.30		
15	11.30	"	161.41

348 Edwin's parlor

Put on 4 pm Jan 6 1880

92

Jan. 6	$20	
7	12.15	
8	22.00	
9	9.00	Total Time hours 48.00
9	6.30	
10	17.15	
11	7.00	
12	11.00 "	" $92.40
12	9.00	
13	11.00 "	" 112.10 "
13	11.30	
14	22.30	
15	11.30 "	" 167.40 "

Put on 4 p.m. Jan 6 1880.

Jan 6	20.26	
7	12.75	
8	22.26	
9	9.00	Total 64.07 hours
9	6.50	
10	19.15	
11	7.00	
12	11.00	" hours 108.06 hours
12	9.30	
13	11.00	" " 128.36 "
13	11.00	
14	22.00	
15	11.00	" " 183.06 "

332 Pat- air hand dump in 94
office over Griffith's desk

Rec 1/2 | Jan 6 1860
Commenced burning | 14.20
burning d-

Busted after running 50 previously
under water

✓ 50 hours

184 Pot – under water
on Laboratory table
Res 145 – 120 hours – } Jan. 6 1880
90 hours on Pot after
commenced burning } 5 P.M.
at =

Jan 6	4.00	
7	12.15 –	
8	22.00	
9	15.00	
10	19.15 –	
11	7.00	
12	11.00 Total 86.20	12 mm
12	9.00	
13	11.00	106.50
13	11.30	
14	22.30	
15	11.30	169.20
16	23.00	23
17		184 hours
18		
19		

Dusted under water
at Jos. Lange C.

340 Jn Edwin's Stalle 96

R 133

Commenced turning at — | Jan. 5-1850. 6.00 P.M.

Jan. 5	4.00	
" 6	20.25	
" 7	12.15	
" 8	12.00	off 5-P.M.
" 9	9.00	Total 67.41 cords
" 9	6.50	
" 10	19.15	
" 11	7.00	
" 12	11.00 "	from 112.42 cords
" 12	9.30	
" 13	11.00 "	" 122.16 "
" 13	11.30	
" 14	22.30	
" 15	11.30 "	" 188.46 "

345 Jas Edwards Hall 97

Commenced turning at | Jan. 6 - 1880
6.00 P.M.

No. 133

Jan 5	4.00	
6	20.26	
7	12.15	
8	22.00	
9	9.00	Total 67.41 hours 2 hr 5 P.M.
9	6.50	
10	19.15	
11	7.00	
12	11.00	hrs 112.46 noon
12	9.30	
13	11.00	133.16
13	11.30	
14	22.30	
15	11.30	187.46

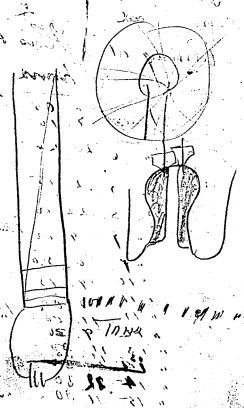
No 176 For lamplight in
front of Edison's house

Rec 167.
Commenced
turning at

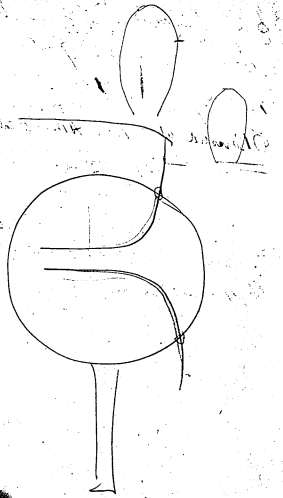
Jan. 5/1880
7.50
Has turned 114
hours and 5 min.

Jan 5	114.05	
" 6	7.10	
" 7	20.26	
" 8	12.15	
" 9	22.00	after 5 P.M.
" 10	9.00	Total 184.56 hours
" 11	6.50	
" 12	19.15	
" 13	7.00	
" 14	11.00	hours 229.01 min
" 15	9.30	
" 16	14.00	
~~" 17~~	~~14.30~~	
" 17	22.30	
" 18	11.30	2 P.M. 07

125 20 [illegible] first [illegible]
20 on bottle connection [illegible]



35-1 Lamp Between Laboratory and office
Re. 117
Commenced burning at noon
Jan 7 1880
$2.00
Operated at 7.30 A.M. Total 7.30 hours



352 Between Office and Laboratory on Campfeat

Res. 122 } Jan. 7/1880 commenced burning at - 5.00

Jan 7. 2.00
" 8 22.00
" 9. 4.00 Total 28.00 hrs

Taken and Put on campfeat at the top of depot stairs

353

Between corner of laboratory ~~[illegible]~~ yard and corner plank walk

Res 135

Jan. 8. 1880

Commenced to ~~[illegible]~~ another lump into my ~~[illegible]~~ post in

854

Lampposts between corner and Thurnwalls Stable

Res. 134

Commenced burning at

Jan 7 1880	
	7.00
Jan. 7.	7.20
" 8	22.00
" 9	9.00 Total 89.20 burn 7.45 6 pm
" 9	6.50
" 10	19.15
" 11	7.00
" 12	11.00 " " 82.25 burn
" 12	9.00
" 13	11.10 " " 102.55 "
" 13	11.30
" 14	22.30
" 15	11.30 " " 156.05

9426
4455
2911

126.30
29.11
127.39

360 In office on Griffiths Clerk
on hand camp.

Jan. 7 1880.

Commenced running 7.00

Jan. 7 $6.15

" 8 22.00

" 9 9.00 Total 37.15

" 9 6.50

" 10 19.15

" 11 7.00

" 12 11.00 . 71.20 mm

~~" 13 9.30~~

~~" 14 11.00~~ . 91.50

~~" 15 11.30~~

~~" 16 12.30~~

~~" 17 11.30~~ . 146.20

~~Remark Cash~~ 71.20 mm

~~Feb 25 To labor bal still running~~

357 Put in telephone room

Rec to the mummy | Jan 7 1880
Commenced burning at | 7.40

Jan 7 6.15
8 22.00
9 9.00 Total 37.15

Busted at 2.40.
Inside glass cracked and broke out

358 for third chandelier
with side lateraling

Commenced burning at Rev. 130 slowly | June 8 1880.
4.30 P.M.

burned 10 hours

June 8 - 11.40
June 8 - 5.00
" 9 - 15.00 Total 27.40 hours

Carbon broke ⅜ inch from ~~top~~ middle
Glass cracked on leading lower
and fellow fell down

365 Jr Denise Home

106

Rec. 120

Commenced hire

Aug. at —

June 8, 1880

4.00

June 8	8.00	
9	15.00	Total 23 hours
9	10.50	
10	19.15	
11	7.00	
12	11.00	67.01 — nom
12	9.30	
13	11.00	87.83 —
13	11.30	
14	22.50	
15	11.30	142.03

362 Phenix Trimmer's Book 107
Rec. 172

in Laboratory —

Commenced Burning at — Jan. 8 1880 4:00 P.M.

Broke after burning ~~the~~ a Total of 15 hours

Cracked inside glass bottom of one leading wire

368 Charley Hummes Bench 108

Rec 127

Commenced burning at — | Jan. 8 1880 4.00 P.M.

Jan 8 8.00

" 9 15.00

10 11.00

34.00 ✓

Inside glass cracked bottom of cones

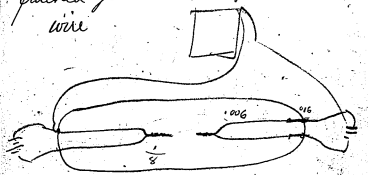
1007

361 on lamppost number 109
6 at the corner of Deane lane

Commenced burning at | Jan. 9 1880 7.00

Broke on the night of Jan 9 1880
8 o'clock burning 1 hour

Cracked glass bottom of one leading wire



371 On Compost - one 13 between 140
the corner of Laboratory and corner
of plank walk
Rez. Jan. 9/1880

Commenced running | 7-12 commenced at - 7 o'clk

Broke at - 10.40 Total time burned
8.40 on the 9th 1880

Carbon broke near clamp
Met glass I see crack running length
wise down glass on leading wire and
I think it follow leading wire through

373 Over Flummers Bench

Experiment —

Rec. 125

Commenced Jan. 9/1880 at 4.00 P.M.

Jan. 9	11.00 A.M.	
9	11.00 lime	
10	19.15	
11	7.00	
12	11.00	Total lime slumped 48.15 acres
~~12~~	9.30	"
13	11.00	" 63.45
13	11.30	"
14	22.30	"
15	11.30	" 123.15

372 Over Tannace Bank 112

Experiment –

Commence timing at Rec 124 | Jan. 9/1880 2.00 PM.

Jan. 9. 11.00
10 19.15 –
11 2.00
12 11.00 Total time 48.15 min
12 9.00
13 11.00 " " 68.45 " "
13 11.30
14 22.30
15 11.30 " " 123.15 " "

~~375 — For Machine shop prod — ended —~~
~~Res 145 — Jan 9 1880~~
~~Commenced running at — 11.30 A.M.~~

375 — in Chandelier by organ
Experiment — Tubes bended.

Res 145 — Jan. 9 1880
Commenced running at — 11.40

Taken away from 9. 10.20
" 10 9. 15 —
" 11 9. 00
" 12 11. 00 Total taken away 195
" 12 9. 00
" 13 11. 00 " 2[illegible]05
" 13 11. 30
" 14 22. 30
" 15 — 11. 30 " 8[illegible]

By ~~[illegible]~~ same —
Body

3/6 Machine shop closed 11.4

~~Hackel — from dope Experiment —~~

~~Eng glass w/po~~

~~Rec. 135 — from 9 1440~~

~~Commenced burning 1856 A.M.~~

d/-

3/6 Commenced Burning at 11.40

Chamberlain near upon

Experiment — from 9/1600

Burner on ship 18.40

Jun. 9 — 10.20 P.M.

9 . 140

10 19.15

11 . 00

12 11.00 This hour 38.55 noon.

Broke on the night of the 12th

115—

366 Suspended on wires
~~at~~ on mercury tube by tip Laboratory

Ra 180 Jan 8 1899
1.00 P.M.

Commenced mining
A—

Taken down to on Aspirants 115—

366 Jan. 9 1899
Ra 130 4.00 P.M.

Commenced mining
A—

Jan 9 ~~8~~ 2
10 ~~11~~ 2
11 2
12 2 Total 20

378 Jos Dennis Dine 116

No. 112

Commenced running at | Jan 9. 1880
4.00

Jan. 9	7.50		
10	19.15		
11	9.00		
12	11.00	Total 45.05 mon	
12	9.30		
13	11.00	"	65.35 "
13	11.30		
14	22.30		
15	11.30	"	120.05

365 — Jno Bonnaker Store 117

Commenced burning at —

Rec 120

Commenced burning at —

Jan 8/1880
5.00 P.M.

Jan 9 — 7.50
" 10 — 19.15
" 11 7.00
" 12 11.00 Total hours 58.30
" 13 9.00
" 13 11.00 . . 63.35
" 13 11.30
" 14 22.30
" 15 11.30 . . 120.05

378 Jno Connishes Store 1174

Res

Commenced burning at — | Jan 8 1880

5:00 P.M.

Jan. 9	7.30	
" 10	18.15	
" 11	7.00	
" 12	11.00	Total 64.45 cords
" 12	9.00	
" 13	11.00	" 65.15 "
" 13	11.30	
" 14	22.30	
" 16	11.30	" 120.45 —

35-2 On temporal at top of stairs south side

Rec. 122

Commenced Jany | Jan 9 1880 11.00 P.M.

Jan 10	9.15		
11	7.00		
12	11.00	Total hours 27.15 now	
12	9.00		
13	11.00		47.45
13	11.30		
14	22.30		
15	11.30		102.15

366 Mr Aptons Dining room 119

Rec 130
Commenced Dining
This P.M.

Jan. 8. 1880
7.00

Burns about 2 hours per. day etc.

already found $6.50

Jan 8	2		
" 9	2		
" 10	2		
" 11	2		
" 12	2	Total 16.50 now	
" 12	2		
" 13	2	"	20.50
" 13	2	"	
" 14	2	"	
" 15	2	"	26.50
" 15			

380. For Chemical Laboratory
one south side first chandelier Chemistry
from Telephone room

Rec 100.
Commenced Gang at-

Jan 10 1880
$6.00

Jan 11 6.00
" 12 11.00 Total 17.00
" 12 9.30
" 13 11.00 37.30
" 13 11.30
" 14 23.30
" 15 11.30 92.00

Taken out

3844 In Laboratory on hand lamp on table

Rec 114

Commenced burning oil — Jan 10 1850 $ 9.00

Jan 11	3.00		
12	11.00	Total 14 days	
12	9.30		
13	11.00	"	34.30
13	11.30		
14	22.30		
15	11.30	"	$89.10

325 Post-in post between laboratory and office. Moved from eight hour area of steps to depot.

Rec. 143

Commenced burning at

Jan. 9. 1880

P.S. 00 A.M.

Burnt about 11 hours and carbon bustles on top plates. Percent

1	~~10~~	~~00~~	
1	1	00	
1	1	30	Total hours burnt ~~star burnt~~ 3 1/2
1	11	00	
1	11	30	
1	12	30	
1	1	30	85.00

349 Jno Affie in Machine Shop.

Res. 142

Commenced Jan 8. 1880

Running at 7.00

Jan. 8	8.00		
9	10.00		
10	10.50		
11	11.00		
12	11.00	Total hrs 82.50	
12	9.00		
13	11.00	"	78.20
13	11.50		
14	22.30		
15	11.30	"	121.50

3.50 for office in Machine 124

Ship.

Ro 139

Commenced running at — Jan. 8 1880 7.00

Jan 8	5.00	
9	19.50	
10	10.50	
11	7.00	
12	11.00	Total 53.40 noon
12		
13		
14		
15		

389 Jas Grant of Edgecombe
Horse

Rev. 120 | Jan 12/1850

Commence | P. 50
running at-

395 – Jos Grant & Office south
– side

Res 141½

Commenced
brining off

Jan. 28/1880

10.00

3 3 Dr Harrell Otis 127

Reg. 122

Commenced Evening at 8

Jan. 12/1880

at — 9.00

39 # Jos. Clemens Sen

R. 100 — | Jan. 12/1880

Commenced | # 9.00

running at —

394 Jn Telephone room

Rio 105 — Jan 12, 1880

Commenced burning at 9.15

Broken glass by chimney

~~Baker Corner or Boston~~ ~~[illegible]~~

~~[illegible]~~

377 Suspended ore mines
near Mt Kenny
Rec. 129 Jan 13 1880
Communicated. 2.30 P.M.
Brunyate

Change by Mr Eagle to ore mines
Pampas

Noted

423 on hand lamp on table in laboratory

Rec'd Rec'd

Jan Chandler organ Blower and assist the same

Rec'd 124 — Jan. 14 1880

Commenced burning at 8.20

Taken over to office and broken by falling off table ~~Total burning time~~

4.00 hours

Taken away

417 In front of Pictures

Commenced Jan 14 1880
Ending 5.30

401 152

Lamps over organ north side

Rec. 115 Jan 14. 1880
Commenced 2nd at 8.40
Carbon broken with forceps at
for clamps at 130/14/1880

Remind months over

Pumps in Lead	Page	Pumps in Lead	Page	Pumps in Lead	Page	Pumps in the Shaft	Page	Pumps in Office	Page
142	1	2143	62	176	82	~~143~~	~~20~~	155	12
159	2	2164	65	207°	83				
189	3	2342	66	~~210~~	~~84~~	~~156~~	~~21~~	2016	13
2175	4	~~2323~~	~~69~~	~~163~~	~~85~~	~~211~~	~~22~~	164	14
255	5	104	70	194	87	347	24	172	15
~~229~~	6	328	71	342	87	329° 326°	82 83	184	16
193°	7	~~321~~	~~86~~	386	88			158	17
162	8	358	105	343	90			198	18
~~165~~	9	362	107	348	92			197	56
~~164~~	10	368	108	347	93			309	57
~~203~~	11	372	112	340	96			332	94
~~155~~	~~12~~	373	111	345	97			360	133
~~[illegible]~~		375	113						
170	19	376	114						
~~143~~	~~20~~	366	115						
~~303~~	~~40~~								
161	54								
311°	55								
~~312~~	~~61~~								

Pumps at Shaft	Page	Pumps at the Office	Page	Pumps at the Cellar	Page	Pumps in Lead		Column Name	Page
248	26	224	41	265	67	~~147~~	~~23~~	~~341~~	~~87~~
218	25	170	42	299	68	236	24	~~336~~	~~88~~
~~222~~	~~27~~	168	43			~~215~~	~~25~~	335	89
~~257~~	~~28~~	181	44			~~243~~	~~26~~		
272	29					~~306~~	~~30~~	~~343~~	~~90~~
315	72					108	31	Steel Pumps	~~Page~~
316	73					153	38	351	99
						232	39	352	100
						~~229~~	~~40~~	353	101
						306	58	354	102
						~~310~~	~~60~~	~~376~~	
						~~240~~	63	361	109
						~~318~~	~~75~~	371	110
						313	76	~~373~~	~~111~~
						334	77	~~372~~	~~112~~
						337	78		
						325	79		
						~~327~~	~~80~~		
						322	81		
						333	85		
						299	91		
						~~345~~			
						176	98		

875 — Hall Lamp in Dr Batchelor's
being one Dr Christy Lamp.

Rec 145 —

144 Dr Jan 15 — 1880

Date		When time commenced		When time ended		Total hours		Remarks
Jan		hours	mins	hours	mins	hours	mins	
Jan	2	5	30					
"	3	~~7~~	~~30~~	12	30	19	30	
"	3	1	15	10	13	9	58	
"	4	8	10	Continued				
"	5	—		12	00	20	50	— 1 hour for supper
"	~~5~~	1	03	5	00	3	47	
"	5	5	40	—				
"	6	—		12	00	17	140	
"	6	1	34	9.	00	8	26	
"	7	1	00	~~7~~ 7	00	~~6~~ 6	00	184.11 total 85.11
"	7	5	45	12	00	6	15	
"	8	1	00	12	00	11	00	
"	8	~~1~~	00	~~8~~ 6	00			
"	~~8~~	7	00	12	20	5	00	
"	9	7	00	12	00	5	00	
"	9	1	00	5	00	4	00	
"	9	5	10	~~6~~		6	50	
"	10	—		6	00	6	00	
"	10	7	00	12	00	5	00	149.15 hours ~~167.15~~

Date		When commenced		When finished		Total hours		Remarks
Jan	10	1	00	9	15	8	15	19.15
Jan	11	5	00	~~6~~	~~00~~	~~1~~ 7	00	7.00
"	12	~~6~~		6	00	6	00	
"	12	7	00	12	00	5	00	
"	12	1	00	~~4~~	00	3	00	14 00
"	12	5	30			~~6~~	30	20 30
"	13	—		~~7~~	00	5	00	
"	13	6	00	12	00	~~6~~	00	
"	13	1	00	30 mins				22.30
"	14	7	00	6	00	11	30	
"	14	1	00	12	00	6	00	
"	15	—		~~7~~ 6	00	5	00	22.30
"	15	7	00	12	00	11	30	
"	15	1	00	~~4~~		6	00	
"	16	—		12	00	5	00	
"	16	1	00	—		11	00	

409-410.

Part in chemical laboratory

By Edison

Rec

Communicated } Jan 14 1880

Evening. } at - 9.40

Taking out. Bath

408 on Griffin's desk
Rec in office

Commenced burning Jan 24/1880
9.30 PM

Gone Cons — fire

Lamp	Page	Lamp	Page	Lamp	Page	Lamp	Page	Lamp	Page	Lamp	Page	Lamp	Page	Lamp	Page	Lamp	Page
142	1	176	98	~~[illegible]~~						308	49	343	90	366	115		
189	2	172	112	275	4					310	50	344	92	357	116		
~~[illegible]~~				255	5					311	51	347	93				
189	3			226	6					301	52	332	94	365	116		
193	4			204	10					300	53	~~[illegible]~~		378	116		
162	8			203	11					306	58	318	95	365	117		
167	9			201	13					312	61			378	117		
155	12			279	19							351	99	352	118		
164	14			211	22					~~[illegible]~~		315	96	366	119		
172	15			236	24					323	69	345	97	360	120		
184	16			218	25					326	71	341	99	354	121		
158	17			248	26					315	72	347	100	325	122		
198	18			222	27					316	73	304	69	349	123		
143	20			257	28					317	74	334	77	350	124		
186	21			242	29					313	76	330	84	393	125		
147	23			206	30					331	78	335	89	377	127		
108	31			207	33					325	79	352	100	409	128		
176	32			210	34					327	80	353	101	440	129		
163	35			255	39					322	81	354	102	387	130		
196	36			229	40					328	82	360	103	419	131		
194	37			224	41					326	83	318	105	403	132		
153	38			244	44					333	85	362	109	~~[illegible]~~	133		
170	42			240	63					332	86	361	109				
165	43			264	65					~~[illegible]~~		371	110				
181	44			264	66					342	87	373	111				
161	55			268	67					338	88	~~[illegible]~~					
197	56			229	68												
~~[illegible]~~				246	59												
104	60			214	62												
~~[illegible]~~	95			298	91												
				~~[illegible]~~													

Batchelors sitting room
418 R1

One wanted in Mr Jordan's kitchen
One wanted in Edisons parlor
Wanted new lamp in Jordans –
Edison wants 169. in his office
Lamp post of engine house at Edison
Use hotel with me.
Mrs. Jordan wants two
360 over the mangered decks
Commenced dancing at
8. 30. Jan. 1880

Mr Edison
Mr Edison M.P.

1 4
1

3 eight windows

Menlo Park Notebook #68 [N-80-03-19]

This notebook covers the period March-August 1880. It was used by Ludwig Boehm to keep a record of glassblowing work that he performed for the laboratory staff. Most of the entries relate to vacuum pumps. Many contain the name of the staff member who requested the work. There are also a few entries by George H. Hill, Samuel D. Mott, and Francis Upton. On page 75 is a caricature by Upton of the incandescent lamp, with the inscription "I shed the light of my shining countenance for $15,000 per share." The inside front cover is inscribed: "March 19th 1880 Ludwig K Bohm" and "G H Hill Menlo Park." The book contains 264 numbered pages. Pages 27-28 and 33-36 were removed and used as Edison's exhibits in the patent inferference case of Boehm v. Edison.

Blank pages not filmed: 220-247, 250-261.

Missing page numbers: 27-28, 33-36.

No. 65

March 19th 1880.

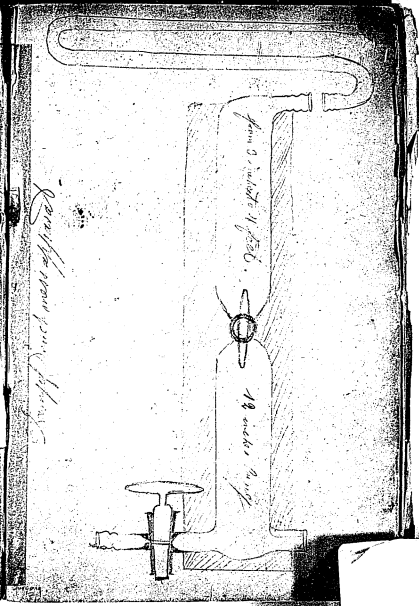
Ludwig H. Böhm.

LIBRARY OF THE

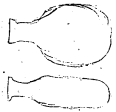
BOARD OF PATENT CONTROL,

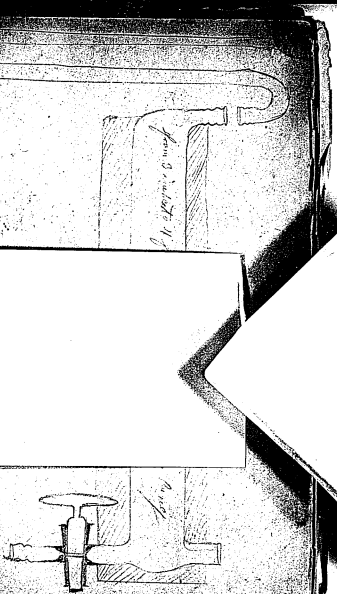
120 BROADWAY, NEW YORK.

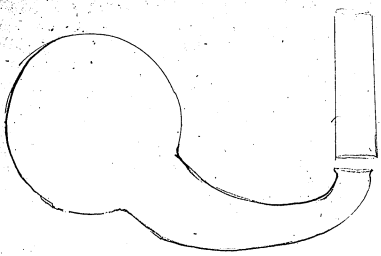
May 1, 1896.

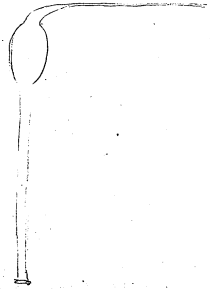


No. 65
March 19th 1880.
Ludwig H. Böhm.



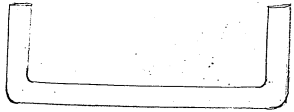




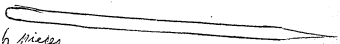


Dr. Morse

Honing



Keney

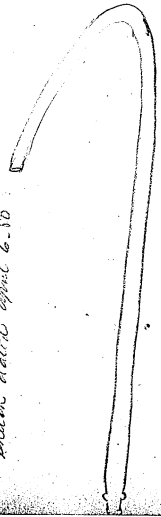


6 pieces.

April 9. 1880

7

Position for single (single stroke) on large
Point dated April 6. 80

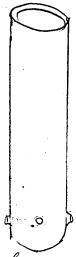


April 10. 1880

Tube for Mr Head's gauge made narrow on the single spirengel pump.

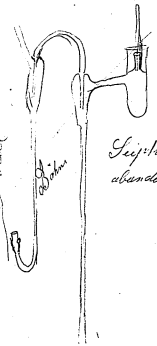
for use in taking meeting telegraph.

April 19th 1880.



Wood
Tube for single syringed pump.

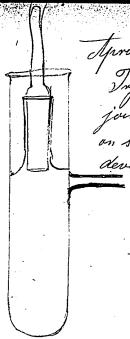
April 18th 1880.

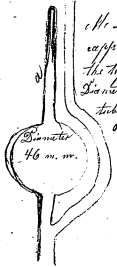


Syringe on the single Syringe abandoned, not good.

April 13th 1880

Tinging Arrangement and joints for sealing on lamps on single Sprengel pumps, devised by Dr. Moses.



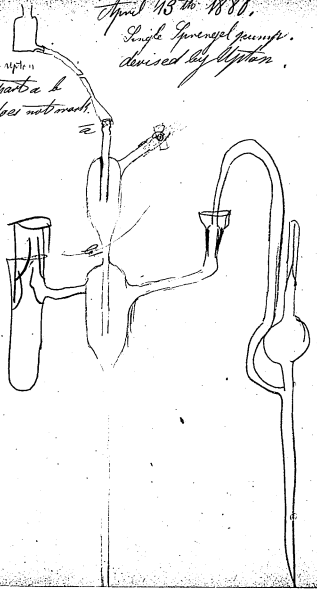


Mr. Lord gauge capillary tube on the top of tube a. Diameter of capillary tube is about 0.33 m. m.

B. Lum

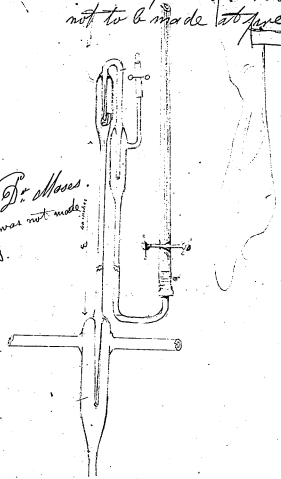
April 13th 1880.

Single Sprengel pump.
devised by Upton.

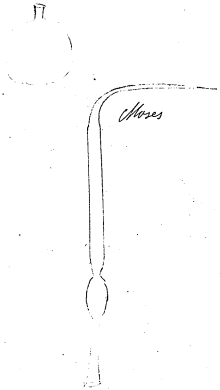


April 13th 1880 19

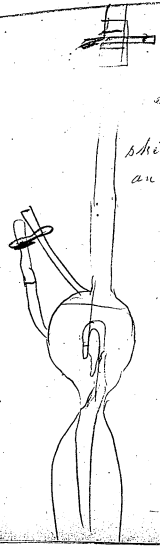
not to be made at present.



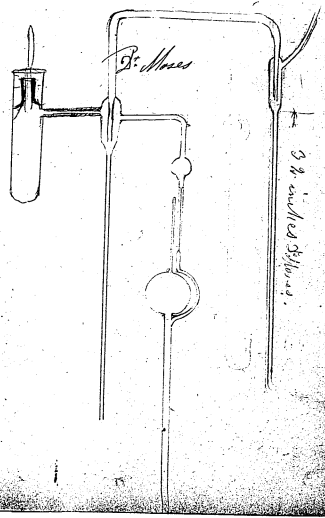
Dr. Moses.
was not made.



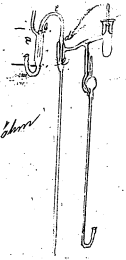
April 15th 1880.



April 14th 1880. 53



April 14th 1880.



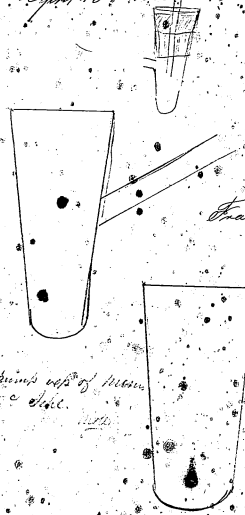
Böhm

part b a = 95 m. m. long
outside diameter is
18 m. m.
tube b c d = 150 m. m. long
part e = 90 m. m.
diameter, 18 m. m.
diameter of the bend
gauge is 45 m. m.
capillary tube
diameter is 1.33 m. m.

Böhm

Böhm

April 16th 1808



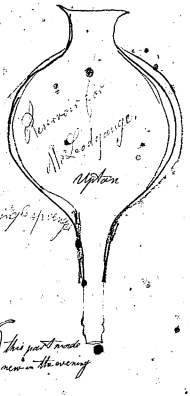
Francis

Few drops weak of Mineral Alkali & Acid.

[ITEM FOUND IN BOOK]

Page 27 cut out and put in evidence in Bohm vs Edison (Edison's Exhibit No. 2)

April 16th 1880.



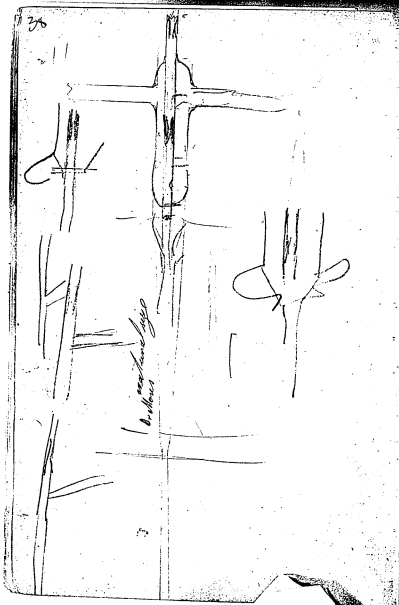
Pages 94 and 95 -
placed as Exhibits
in Interference
Böhm vs Edison
(Edison's Exhibits 3 and 4)

April 19th 1881

37

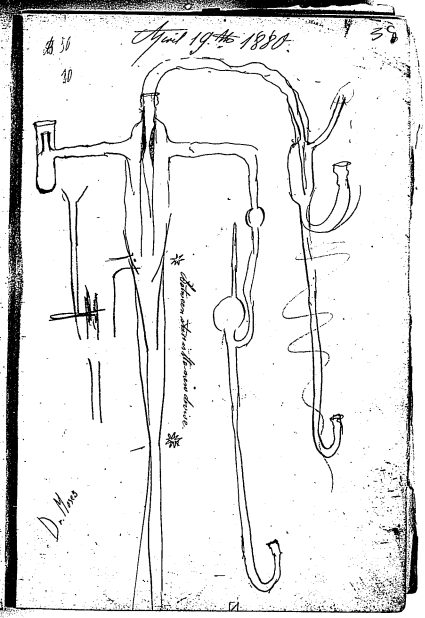
1 piece

Witten

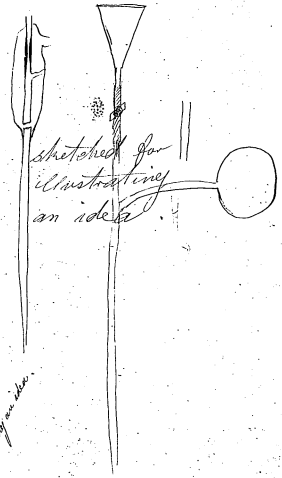


#36
10

April 19th 1884.



April 19th 1880.

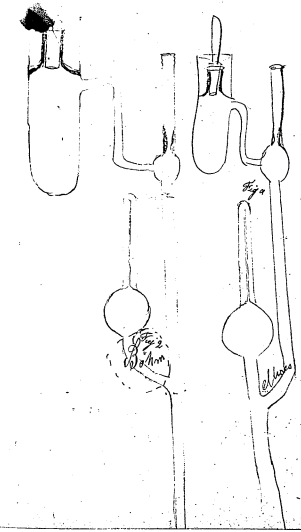


sketched for illustrating an idea.

sketch for illustrating an idea.

Sketch on page 43 shows a device of a Sprengel pump in which the Leadgauge tube and fall tube are one tube. Fig 1 shows first device. Fig 2 shows second device. Fig 3 was devised by Dr Moses. Modification shown in Fig 2 was devised by Dr Morse

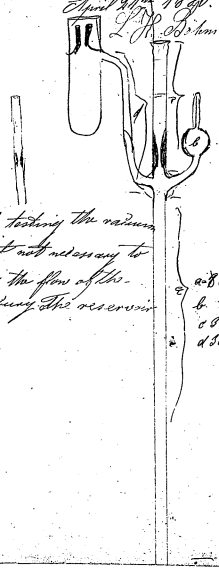
April 20th 1880.



Pumps on page 45 was device
April 21st 1890 mounted with metal.

59: 1200 | 1914
1200
1200
1400
1400 | 52
3 | 15

April 21st 1890.
L. Th. Böhm



for taking the maximum
is it not necessary to
stop the flow of the
medium the reservoir

a 800 m. m. long
b 45 " " in diameter
c 800 " " long
d 500 " " "

Böhm

Пуфан

1

1176 X 760

760

70560

8232

893,760

1

893,760

2

1787,520

117

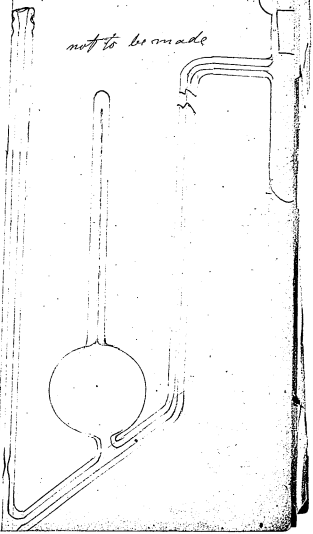
1

80,000000

April 22nd 1880.

Dr. Mayes

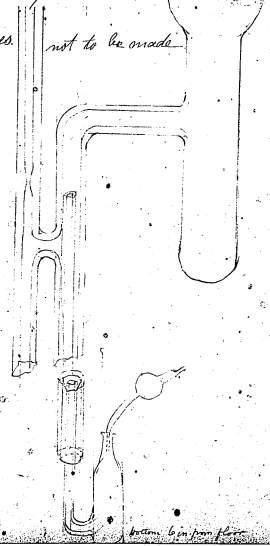
not to be made



April 23rd 1880

Dr. Moses.

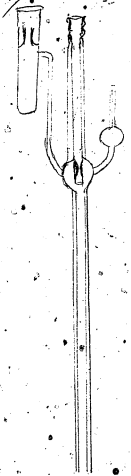
not to be made



bottom 6 in from floor

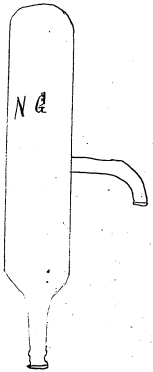
April 23rd 1881

J. Bohm



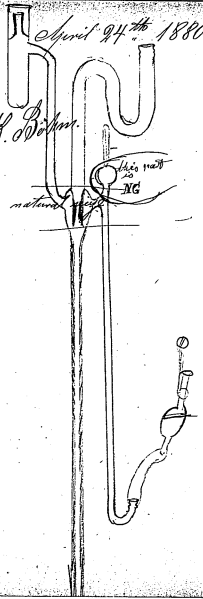
April 24th 1880.

J. H. Bohm.

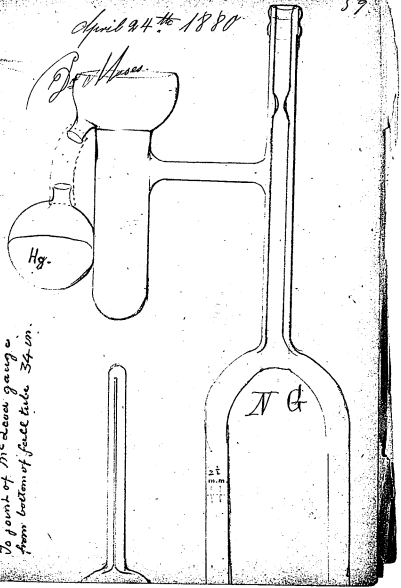


April 24th 1880.

L. H. Böhm.



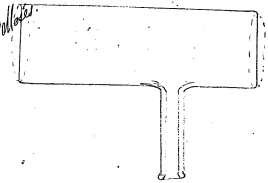
April 24th 1880



To point of McLeod gauge from bottom of field tube 34 in.

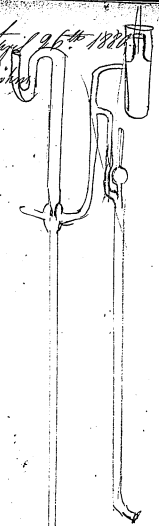
August 26th 1880.

Dr. Wilder



April 26th 1882

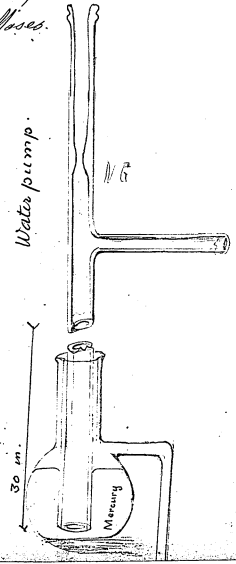
L. H. Bickers



Written April 1880.

Dr. Moses.

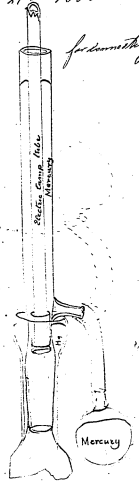
Water pump.



April 27th 1881.

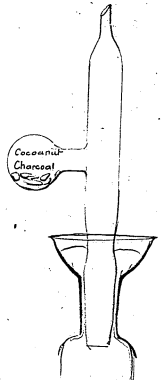
Dr. Moses. for measuring lamps.

N.C.



Ottawa 26th 1890.

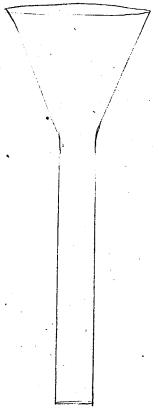
Dr. Moses.



April 28th 1880.

Hammer

Hydrosquinone
anthraquinone



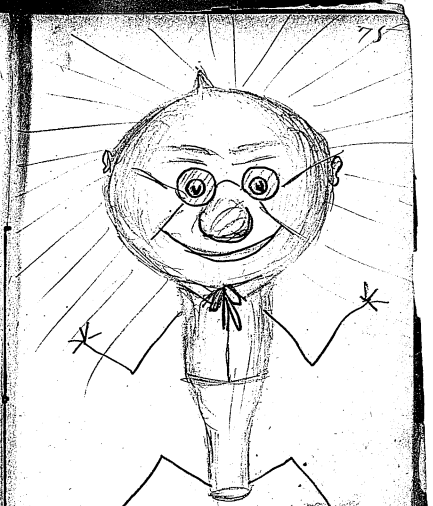
April 30th 1881

small gauge for combination pump.

Dimensions: length of capillary tube = 135 m.m.

Diameter of bulb 43 m.m.

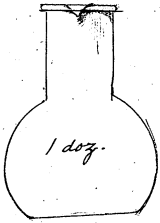
Bohm

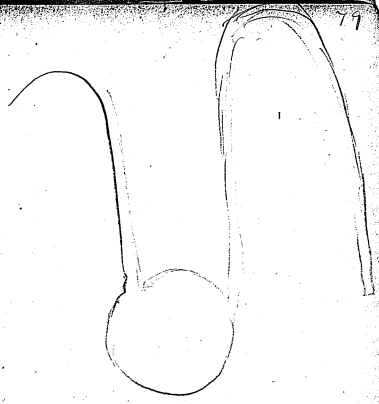


I shed the light of my
shining countenance
for $15,000 per share

Opened 30th 1881.

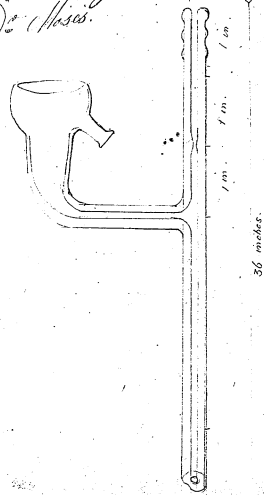
Dr. Morris.



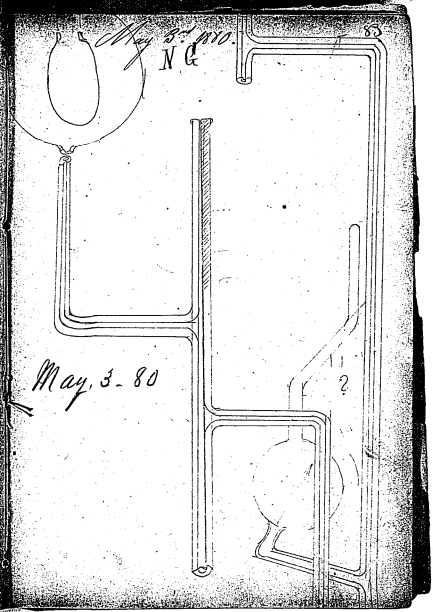


~~[illegible]~~ May 1st 1880.

No. 1 Hases.



May 3. 1880.
N G



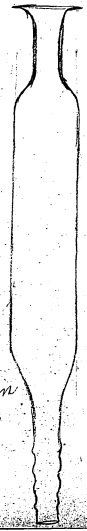
May, 3. 80

?

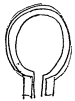
May 3rd 1880.

4. 25
2. 30
55.
2. 40
95
4 35
2 30
160.
8 50
2 25
45
2 30
50
15
30
35
350
130
480

G. H. Böhm

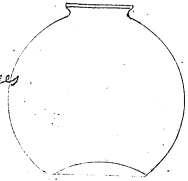


473 pieces ordered by Mr. Edison.



Ale May 5th 1880.

D. Moses



2 oz.

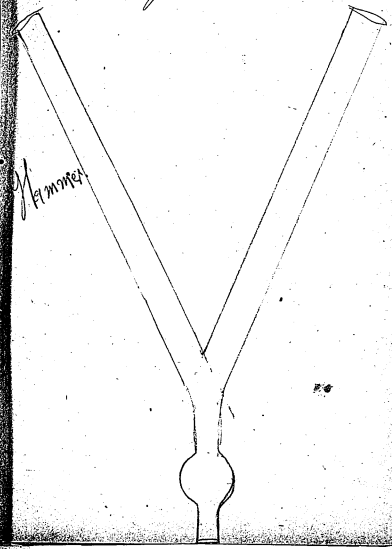
Yamsey.

May 6th 1888

Dr. Moses.

½ doz. O. Pill.

May 1st 1880.



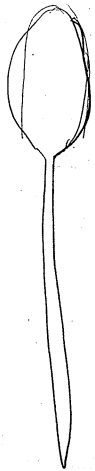
May 8th 1881.

6 pieces.

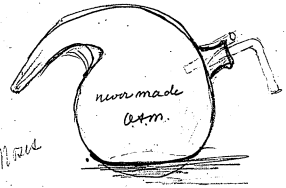
1 piece

14 pieces

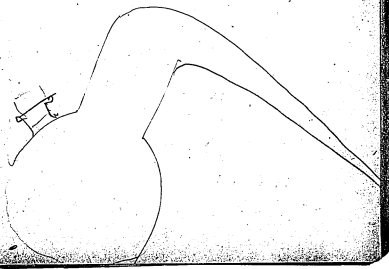
Dr Moses.

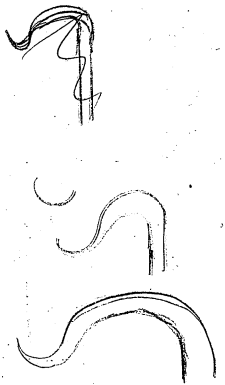


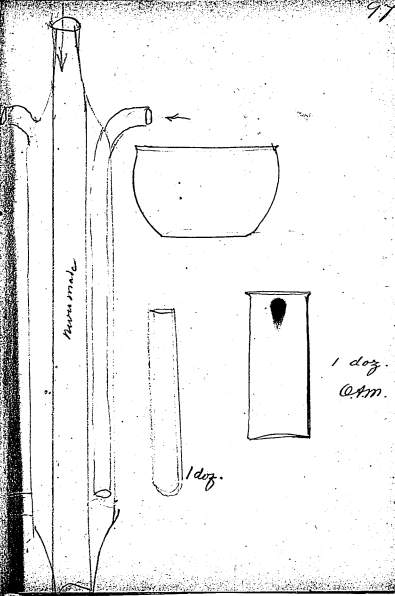
May 8.



Dr. Mau



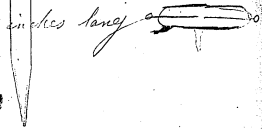



Burrmale
1 doz.
Atm.
1 doz.

May 18th

4 highly exhausted spark gauges ordered by Mr. Griffin for the military academie in West point.

about 8 inches long



May 29th 1880.

Dr. Moses.

May 31st 1880

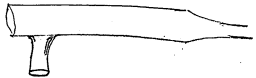
finished gunnies brought up in the Laboratory	18
in the Carpentershop	2
for testing taken out	2
brought up in the Laboratory	14
" " " " "	13
Total	51
send up in the Laboratory	18
carried up	23
" " " " "	9
" " " " "	8
Total	100

Finished on the 1st instant.

First Hundred.

L. H. Bilton

rupees	45
"	43
rupees	86
"	19
altogether	105



June 9th 1880.

Finished pumps send up in the laboratory 10
carried up brass 12
" " " 21
" " " 12
" " " 14
Total. 30

June 10th

Finished pumps send up in the laboratory 24
brought up brass 12
" " " 16
Altogether . . . 102

J. H. Bishop. Finished on the eleventh.

Second Hundred

Jens 10th

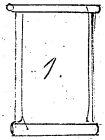
Dr Moses

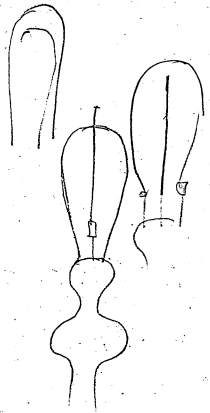
1 Spoon. Opm.

James Reid

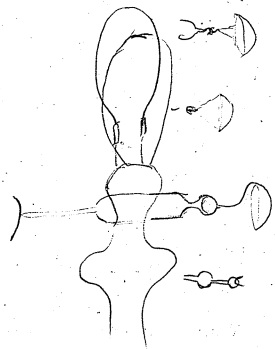
Tallow holder

Atm—



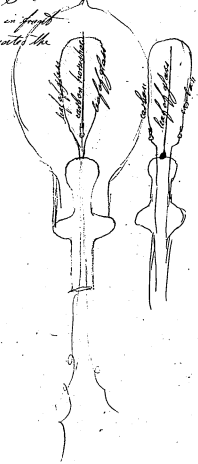


June 15 80



Sept. 15th 1879
T. A. Edison Ph.D.

Half of glass is in front point, it separates the carbon logs.



R. Sher

June 15th 1861.

Dr. Moses.

Incrassometer for determining the specific gravity of solids.

The whole apparatus made of glass.

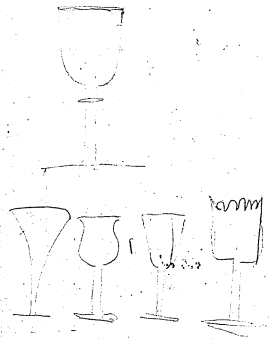
a The shallow cup for putting solids in.

b Graduated.

c Shallow cup of glass for weights.

Bottom.

1.16 94 cups
9
2
1096



June 18th, 1880.

Pumps finished	25
" "	25
Total	50

June 19th

Finished pumps send up in the Laboratory	25

June 22nd

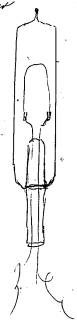
Finished pumps send up	26
Grand Total	101

Third Hundred.

Ludwig H. Böhme

June 19th 1880

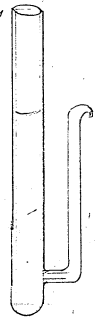
Half a dozen ordered by Mr. Edison.
eight candle power
lamps.



0 = + pc. —

Juni 21.st 1880.

Dr. Moses

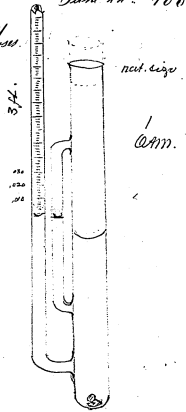


(1)
Cam.

1/9

Juni 22nd 1880.

D: Moser.



June 27th

T. A. Edison

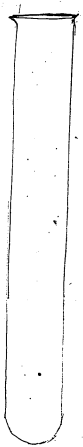
six eight candle power lamps more small size without globes like those on page 118. Inside parts like sketch.

not blown up at a.

June 21st 1889.

Dr. Moses.

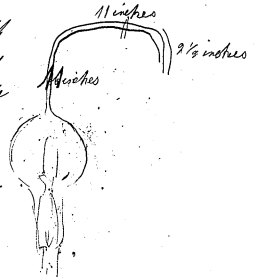
Test tubes 1 Doz.
made by Ben.



$1/11$

June 25th 1880.

2 1/4 high
11 long
6 deep



June 28th 1880.

Atm.

July 1st 1880.

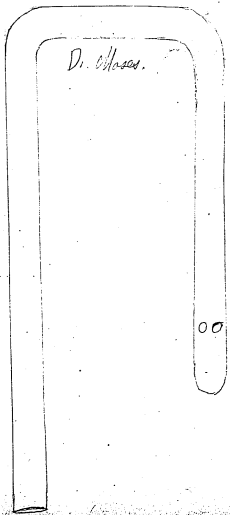
Finished pumps send up in the Laboratory	25
Finished pumps send up in the Laboratory	25
Total	50
Finished pumps send up in the Laboratory	25
Pumps send up in the Laboratory	19
Total	94
Pumps send up in the Laboratory	6
Grand Total	100

Required to day 13

Fourth Hundred

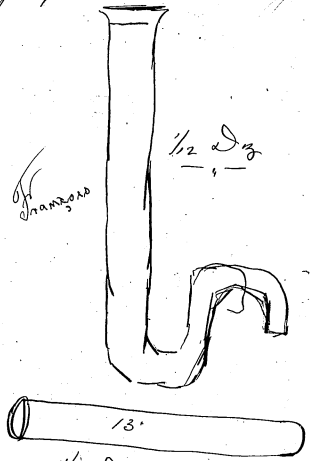
Ludwig K. Böhm.

July 1st 1880



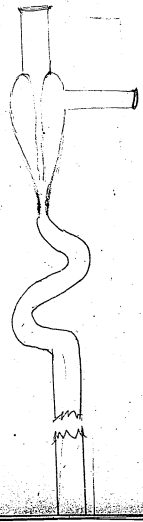
July 3rd 1880

July 3rd/80



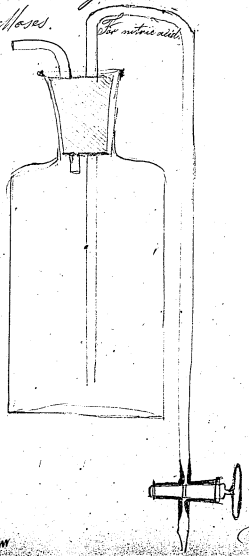
July 6th 1880.

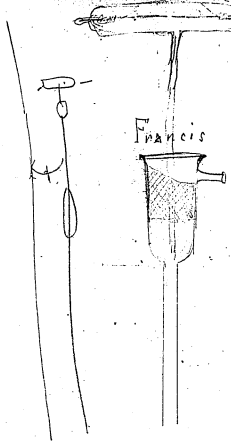
Dr. Moses.



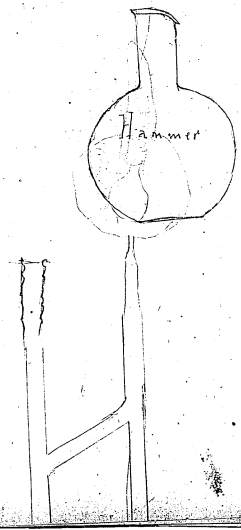
July 6th 1881.

Dr Wilmore.





July 6th 1880.

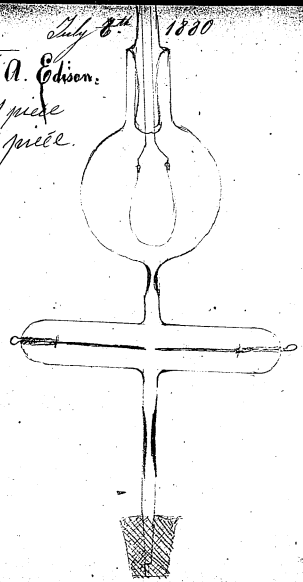


July 8th 1880

T. A. Edison.

1 piece

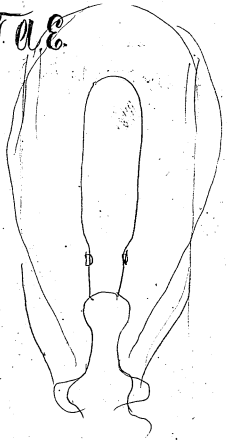
1 piece.



specific gravity bottle Dr. Moses.

July 8th 1880.

T. A. E.

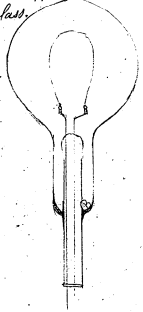


Robson

July 1880

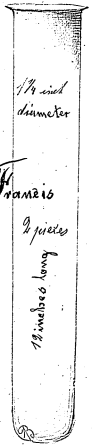
For gauge platinum only

The whole apparatus is to be made of lead glass.



W. François

July 9th 1880.



Francis

150

July 10th 80

6

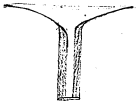
One (1) Nest-Test-Tube

L. Jehl

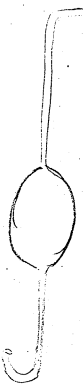
July 13th 1880

75-1

Mouth piece of for blow pipe Dr. Hoss



July 13th 1880



Transcribed

July 13th 1880.

Finished pumps carried up in the Laboratory	25
Finished pumps send up in the Laboratory	25
Total	50
July 14th.	
Pumps finished and send up to the Laboratory	27
Altogether	77
Pumps made before	403
Throughout grand Total	480

Repairs

75 more on

July 14th 1880

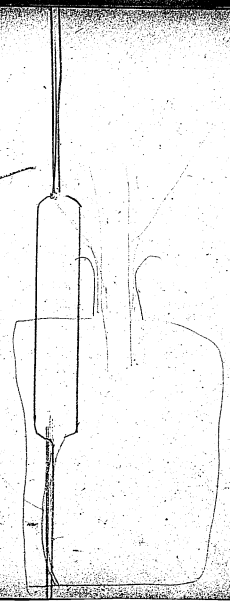
Ludwig K. Bolme

154.

July 14 80

July 14th 80

Geo. Hill



July 15th 80

8/12 Dr

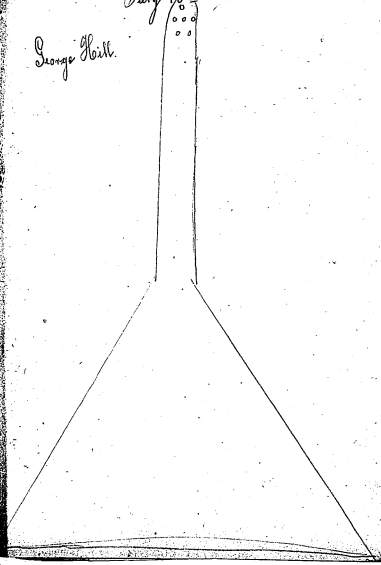
Test Tube for

Rack

Francis

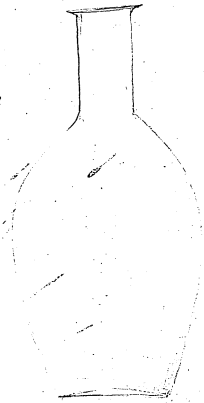
July 16th 1880

George Hill.



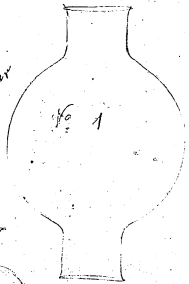
July 18th 1880

Hammer

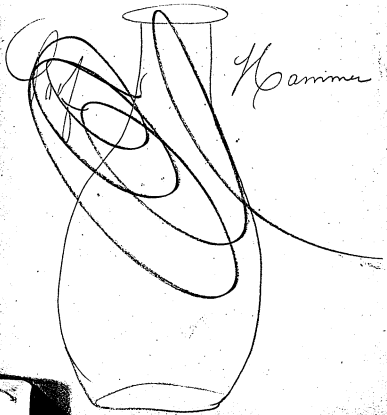


July 12th 1880

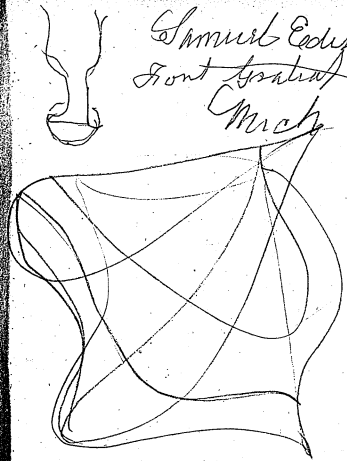
Hammer



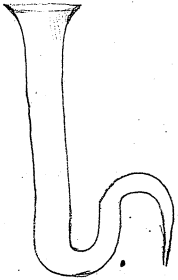
July 20. 80.



Samuel Edison
Front Gratiot
Mich

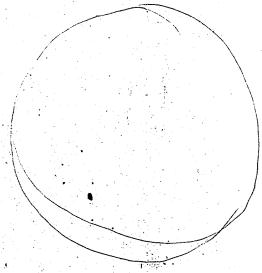


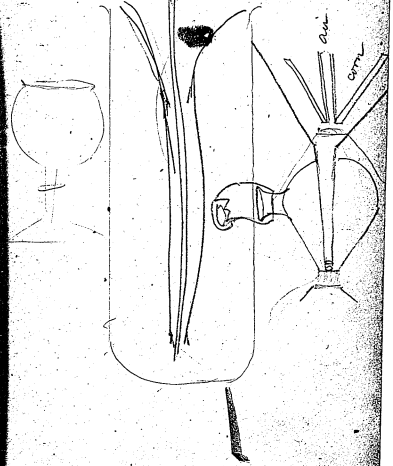
Geo Hill



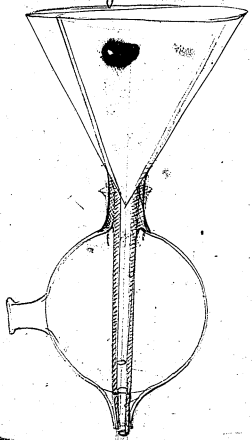
Bulb
200
50
250.

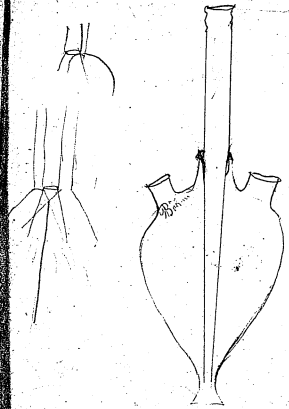
Hamm





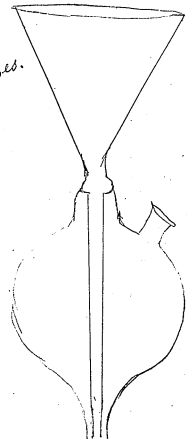
July 9th 1880





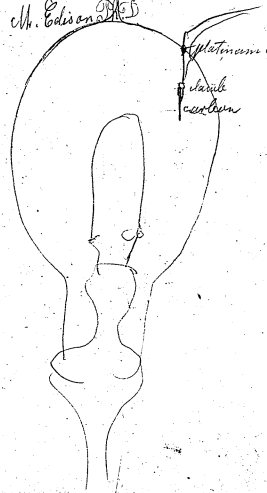
July 24th 1880.

D. McLeod.

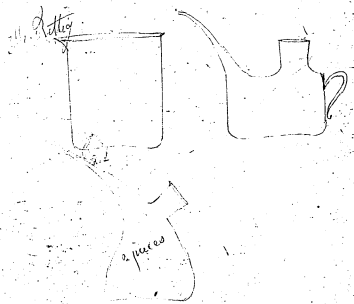


July 26th 1888.

Mr. Edison Fig 3



July 27th 80.



circumference 31 inch.

3.14 : 1400 / 4,0
1256
144
12/500
36/250
18/185

3.14 : 14.43 | 4,050907
12.56
1.8470
1.5710
3.000
2.926
0940

1/5
12/4 : 3

3.14 : 3.100 / 9,14
2826
274
2000
2087

31
9
279
8
22
14 1/2
4 1/2
56 1/4

28
22
56
56
9:616 | 88
56
56
56
4/4

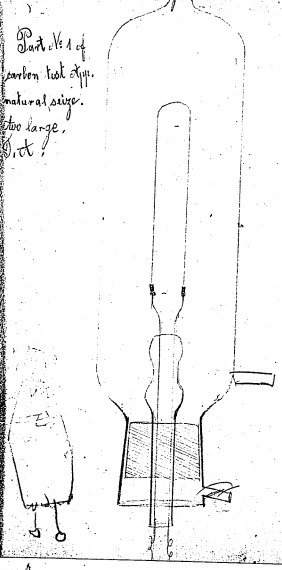
12 1/4 : 134 | 94 3/4
134
134
11:4444 | 6282
42
34
56
14
9/4

12 1/4

88:6282 | 4 3/4
676
66 / 3/4

Sept. 29th 1880

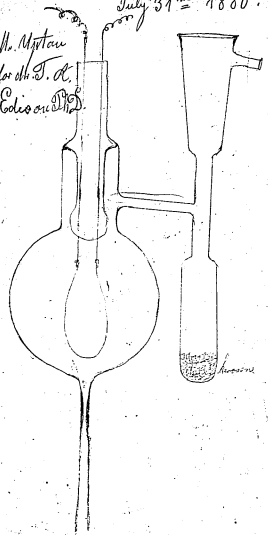
Part. No 1 of carbon test app. natural size. two large. G.t.



Mr. Mott

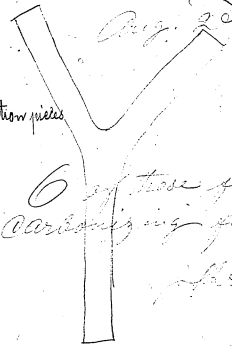
July 31st 1880.

Mr. Martin
for Mr. T. A.
Edison



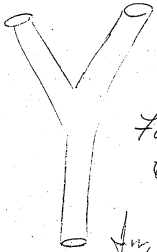
Aug. 2 80

connection pieces



6 of these for
carbonizing furnace
Sherwin

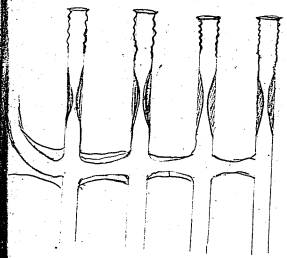
Aug. 3rd 80



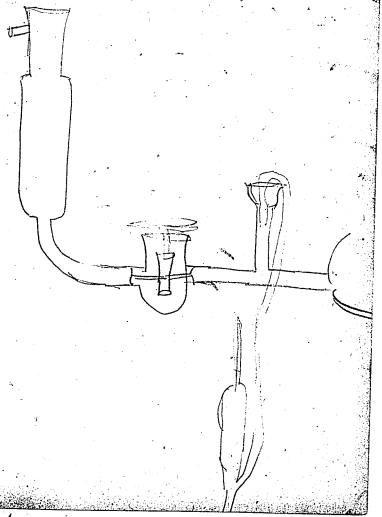
Tour (4)
Connecting
tube.
for Carbonizing
Furnace.
Turnin

Per California

Aug. 3rd 1880.



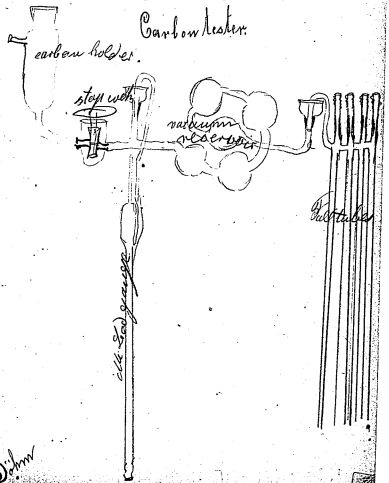
Aug. 8th 1882.



Aug. 5th 1880.

T. A. Edison Ph D.

Carbon holder.

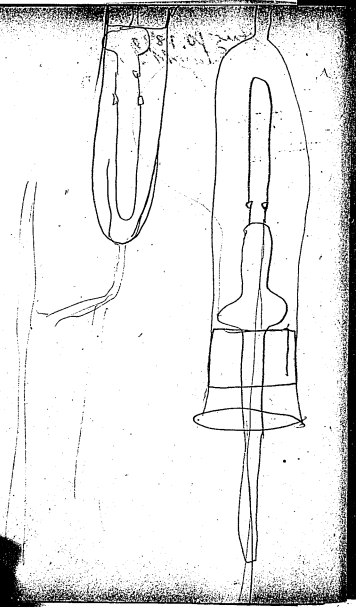


Bichm

Aug 11th 1880.

Glasses from
Rabmay

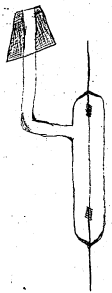
188



Aug. 10, 1880.

Geo. H. Hill

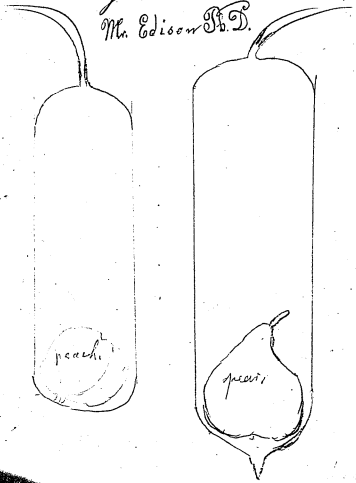
2 pieces.



A. Bohm

Aug 16th 1880.

Mr. Edison Ph.D.

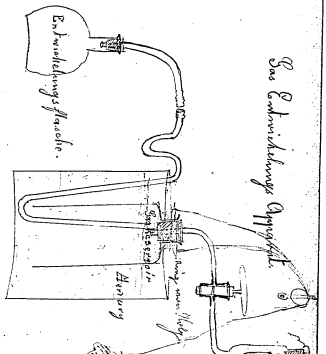


Witnessed by

Aug. 18th 1880.

D. Hird.

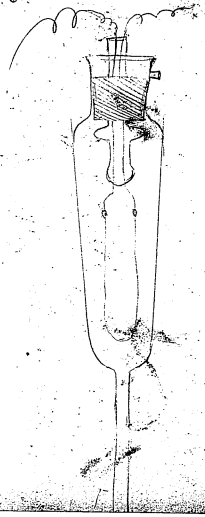
Das Entwickelungs Apparat.



Böhm

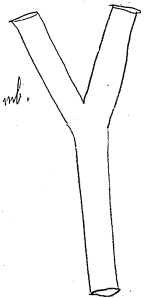
Aug 14th 1880

M. Edison P. T.



Aug 18th 1880.

Holcomb.

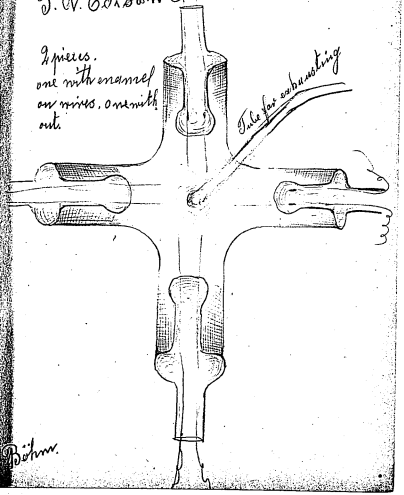


Aug 18th 1880.

T. A. Edison Ph. D.

2 pieces.
one with enamel on wires. One with out.

Tube for combustion

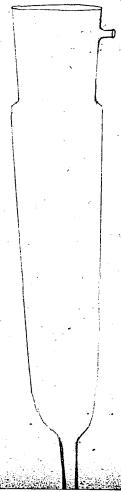


Bottom.

Aug. 18th 1880.

T. A. Edison Ph. D.

mélange vapeur.



2 pieces California

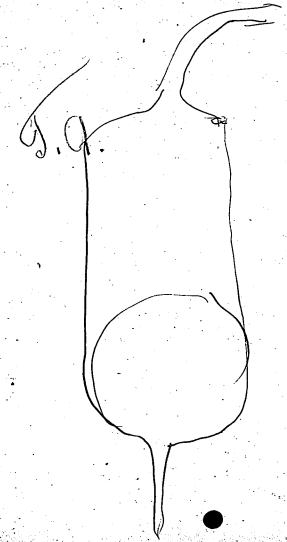
Aug 17th 1880.

(D. Hid.)

Combustion tubes

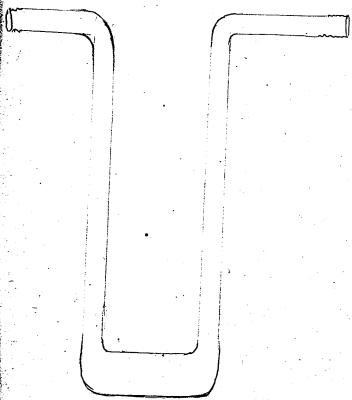
4 pieces.

Böhm


J.G.

Aug 26th 1880

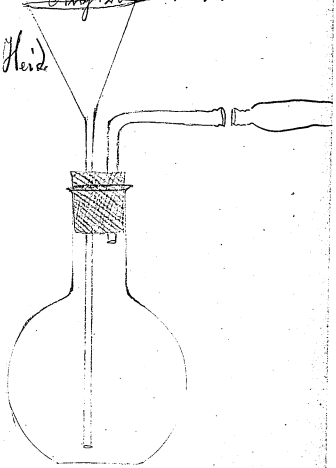
D: Held.



P Johan

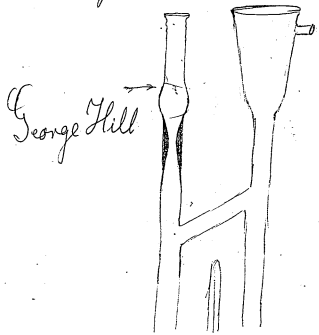
~~Aug. 26th~~ 1888.

D: Heid.



Böhm

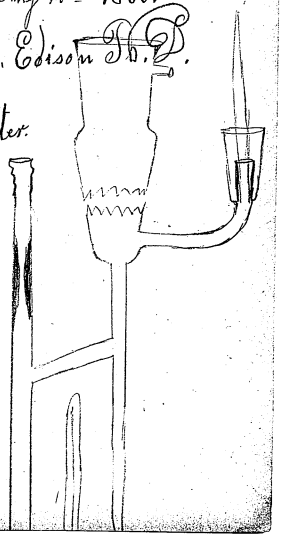
Aug 20th 1880.



Aug 20th 1880.

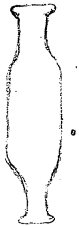
T. A. Edison D.D.

Carbon tester.



Böhm.

Aug 21 1880
for the Carbon Tester-
G.H.H.



Aug 23rd 1888

Francis Gail.

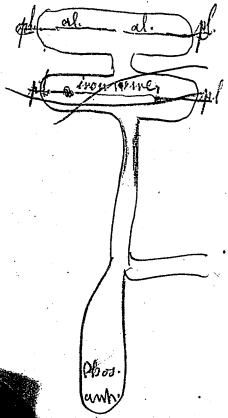
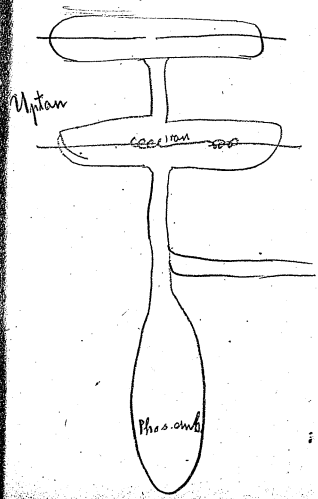
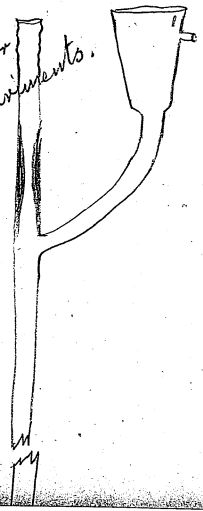

al.
al.
Pl.
Pl.
Pl

Fig 234b 1880.



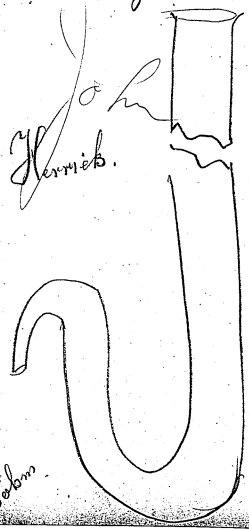
Aug 24th 1880.

Pump for Fruit experiments.



B.

Aug 28th 1880.



Herrick.

Cohn.

John S Manning

22
22
47
47
484
12
968
484
58.08

2.
1827 | 5808 (3.3/7 ans fe—
5481
327
7827

4.0— after

1500
1500
2500
4500
9/3 8400
~~2400~~ 43000
22

20 ~~00~~ 50 E
10,000,000 mm.

Ernst Berggren
Ludwig K. Böhm

200
10.050
910
3,000,000

A B C D E F

Dem Jannie

W. Holger

J. F. Jannie

Holger

Bann

Louis Bohm

26
312,50
312,50

Menlo Park Notebook #70 [N-80-01-02.2]

This notebook covers the period January-March 1880. Most of the entries are by Charles Batchelor. A few entries are by Edison. The name Martin Force appears occasionally as a witness. Most of the material relates to the development of the carbon filament lamp. Included are notes, calculations, and drawings of filaments and clamps; drawings and notes on carbon molds; notes and drawings relating to a series of carbonization experiments; and a few notes and drawings of dynamos. The book contains 192 numbered pages followed by 12 unnumbered pages. The pagination is irregular. In the first part of the book only the right-hand pages are numbered; for pages 94-116, only even numbers are used. A few pages near the middle of the book lack numbers.

Missing page numbers: 125, 135, 178.

No 70

16.30

~~1200~~

~~60,000~~

16.30 1600

1600 1600 1600 1600 1600

1600 1600 1600 1600

1370
365
6850
8220
4110
4000.50
50.00.50

~~STAMPED 76 95.00~~

New Commutator Jan 2nd 1890

Chas Batchelor

902

M. N. Tong

No 70 16.30

1200

60000 16.30 1600

1600 1600 1600 1600 1600

1600 1600 1600 1600

LIBRARY OF THE

BOARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

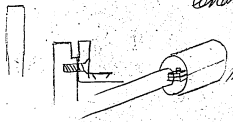
[illegible]

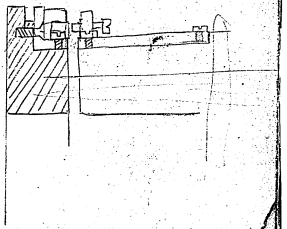
[illegible], 1896.

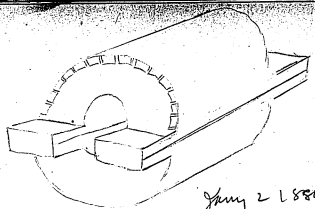
$1446.76 $500

New Commutator Jan 2nd 1880

Chas Batchelor







Jany 2 1880

Pae

Chas Architector

M. N. Prop

Lamp. cost of clamps and wires

Weight of
10 pair of clamps and wires } 6.975 gr

Cost of Platinum $5 per oz.

10/6.975
.6975 weight of platinum
in one lamp

Car
Chas. Batchelor
Martin A. Forsyth

6

27.2 / 30 = 6.12

3.03 × .005 = .01512 → .03030

1.82 × .025 = .0910 → .0364 → .04550 → .182

3.03 × .09 = .1818

3.03 × .03 × 2 = .1818 → .0303 → .0909 → .2121

3.03 × .005 × 2 = .0303 → .0182

1.82 × .025 × 2 = .0455

1.82 × .005 × 2 = .0091

.0546

.0910 → .0182 → .1092

1.82 × .025 → .0910 → .0364 → .04550 → .0182

.0182 → .0091

3.03 × .02 × .09 = .0546 → .0182 → .0182

.0182 → .0182

.0182 → .0182

.

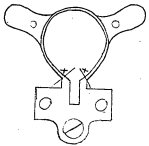
Given Jan 2 1880 Tag 7

20 Cells of 2 Volts each and
·2 ohms resistance
What is best way of putting
them for heating platinum
4¾ long and ·04 resistance
12 hot

20 Cells	Intensity	Total ft lb	17·111	Outside 498
10 "	of 2 quantity	"	15·43	1680
5 "	of 4 "	"	11·100	3600
4 "	of 5 "	"	10·011	4296

Chas. Batchelor
M. A. Trace

Cutting mould for carbon
Jany 2 1880 2/3 the length of
the other one
and to be made
from paper ·0065
instead of ·009



Jan 3rd 1880
Chas Batchelor
M M Co

Length from X to X 2·65
Width when cut ·13
thickness ·0065

This will make lamp of
110 ohms and 2/3 surface
of ordinary "Horseshoe"

January 2 1880

New Commutator

Tas Macpatchelor

1 Must be split and held together by two rings

2 Must be separate from the part that the wires are soldered to

3 The commutator must fit into a recess and bolt to the part that the wires are fastened to by three bolts

4 The brushes must be twice as wide and consequently the commutator twice as wide

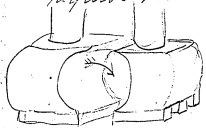
5 Commutator brushes must both be fastened to a circle having the centre of

shaft for its centre and both move together by a handle on top

6 End brushes must be tried

Jan 9th 1880

Ellison says that as regards the cutting of the plate underneath the large magnets they should only be grooved on one side so as to allow the air to be drawn in and taken round the armature —



$\frac{1}{4}$ inch circle clamps

Jan 9 1881

Tap

·25
·5 4
1 0
2 5
·7 5
·7 5 0
·1 5 7 5
·5 9 7 5

·5975
·0225
·5 9 7 5
·0 2 5
·5 9 8 7 5
1 9 5 0
·0 1 2 5 7 5
·0 1 4 9 3 7 5
·0 2 9 8 7 5 0
·0 0 5 9 7 5 1
·0 3 5 8 5 2 5 surface

·5945
·0 2 5
·5 9 4 5
1 9 8 0
·0 1 2 5 7 5
·0 1 4 9 3 7 5
·0 2 9 8 7 5 0
·0 0 5 9 7 5 1
·0 3 5 8 5 2 5

·5945
·0 6 5

1

0149375

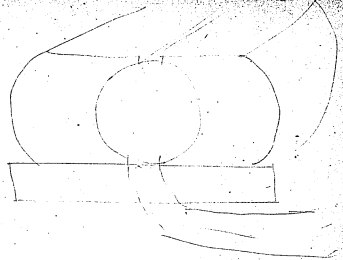
$\frac{1}{4}$ circle with $\frac{3}{16}$ out for clamps

·2121 ÷ ·036

·036 / ·2127
4 / 212
9 / 53
5 3/9

·036
6
·216
4
·212

That is 5 3/9 of these to one of our regulars.



T R
Jany 9 1880
Chas Batchelor

$C = \frac{E}{R}$ 100

3000 × 30 × 5 =

30
90000
5
450000

36 | 450
~~11~~ 12
12

4
4
16
12
3000
36000

$\frac{J\ R}{E.M.F.}$ $\frac{J\ R}{}$ = □ inch

Thomas Allen

Jan 16 1880
Chas A Batchelder

TAE

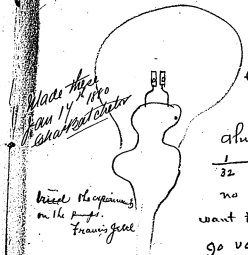
Experiments

Jan 16 1880

TAE

Chas A Batchelder

Also one platinum
also one iron
aluminum Clamps
$\frac{1}{32}$ inch apart
no carbon
want to try spark also
90 volts —



Made this
Jan 14th 1880
Chas A Batchelder

tried the experiment
on the 20th.
Francis Jehl

Made this
Jan 14th 1880
Chas A Batchelder

tried this
Francis Jehl

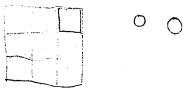
Carbon this shape

TAE

Made this Jan 17th 1880
Charles Batchelor

Carbon This shape

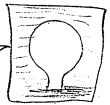
Straight Carbon
Made this Jan 20th 1880
Charles Batchelor



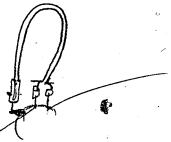
Jan. 16 1880

Chop Switch

Car



9/16



Date Jan 16 1880

TOR

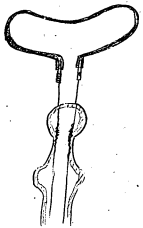
Make 6 lamps with 20% Platinid clamps and wire and screws — old thickness — so as to get more pressure

Jan 16. 1880 35

Leave the carbon like this; that is with longer shanks

Made by
Chas Batchelor

Made these
Jan 17th 1880
Chas Batchelor



Jan 25th 1887

Make one
Carbon turns edgeways

Made Jan 25th 1880
Chas Batchelor

Make loops ordinary
size and large
base lugs on

Made Jan 24 1880
Chas Batchelor

Make some loops of Carbon with
~~Staked on~~ Lac rubbed over
~~them~~
~~Carbon~~, well in, and then
cut the loops regular
size

Edison's Exhibit
Exhibit S for identification
Dec. 27, 1883
M H Kingsland Notary.

Edison's Exhibits
Exhibit S
J. R.
M Mary

Get piece 9 thousandths card and cut 1" X ½" and put between steel plates and put on as much pressure as possible in press see difference in thickness also in length and width

Before pressing 1" X ½ X ·0095
After pressing

Make loops of bank note paper
3 thousandths as as ½ measure
100 ohms same as other loop

These were tried and gave
a gas jet with so small
an amount of Energy that
it would take 22 for a HP

Chas Batchelor

Make loops of Manilla Hemp's
fibre –
755 ohms when cold
Gives us excellent light
540 when hot
This gives light equal ¼ gas jet
and ~~[illegible]~~ equals 64 per HP.

Chas Batchelor

Jan 24th 1880

Took Manilla hemp and knotted thread on ends as :- then pressed it between smooth vise and carbonized in carbon ◯ with hole in

Chas Batchelor

1 Jan 24th 1880

Made loops of Manilla paper
6 thousandths - pressed -

Made these:

Paper before pressing ·0055
" after " ·0040

Chas Batchelor

Jan 24 1880

Took some of the 6 thousandths paper and put under pressure of three men on screw press; this reduced the thickness to 4½ thousandths in place of 6 thousandths —
When carbonized these were particularly straight

Before pressing .006
After " .0055

Have made 12 of these Jan 28th 1880
Chas Batchelor

Jan 24 1880

Make loop of 'Bank note' 3½ thousandths — pressed — and circle ⅓ larger than loop on page 41

Before pressing ·0035
after —

Jan 24 1880 57

Make two more loops same as shown on page 41 but have the bank note paper pressed

Made these and numbered

Chas Batchelor

Jan 27th 1880 53

Made some loops of Manilla hemp fibre & single fibres with tissue paper rolled up on the ends and pressed hard on to the wire this carbonized in Chamber X & with former in inside

Chas Batchelor

·015
·045 45 | ·210
·225 | 5

·3

2

Jan 30 1880 55

Made three lamps with Manilla hemp — ~~these~~ ends covered with tarred Campblack flattened out
These were 2 inch long and 6 by thousandths thick

Chas P Chester

Jan 20th 1880

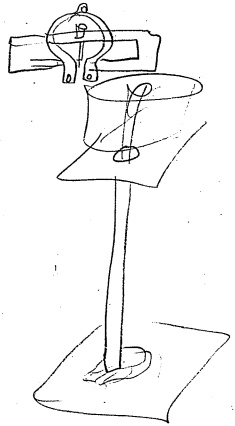
Made 3 lamps of hemp ~~[illegible]~~ (Manilla) soaked in ~~linsed~~ Slive oil – The ends made of paper tightly twisted round and flattened out –
Paper was also soaked in boiling Linseed oil

Chas Batchelor

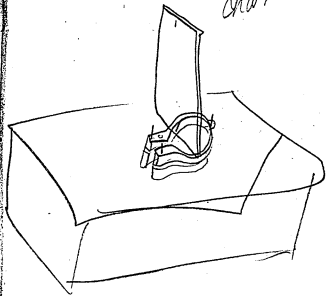
Made hemp fibres with clamps of plumbago, graphite and as used in lead pencils — they have got too much stuff mixed with them for us — seem to swell up and form gases or arcs which burst up the clamps

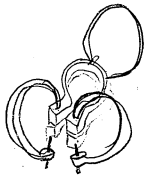
Chas F Batchelor

Clamps made for these were just a cylinder of graphite with hole to peal on wire and holes in top for carbon loop



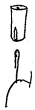
Tel 1 of 1880 61
Chapsatchin





Feb 3 1880

Made carton clamp. of Wallace cartons to thick — slotted the bottom and doubled the core and pushed on so:—



Chas Batchelor

(684)

(684)

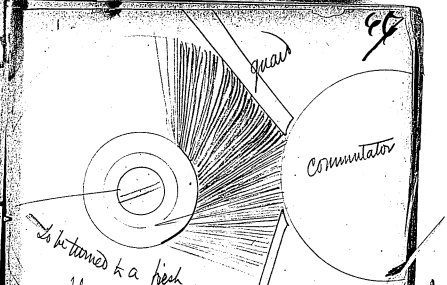
Portland

Portland

Portland

Constitutionally

Make wit coil spring made
as to turn a little itself
if wears away fast



Circular
Commutator brush
Charles Batchelor
Feb. 4th 1880

11 1 1 1 1

75 - 1 .24
37½ - hour 48
19 - .96
9½ - 192

7½

* 7-½ men

35

7½
5

37½

15

25
10
250
30
7500

7500.
775

$\frac{27\frac{1}{2}}{1000}$

$\frac{3}{100}$ wide

$\frac{5}{1000}$ thick

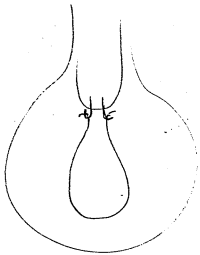
3 inches long

Feb 4 1880

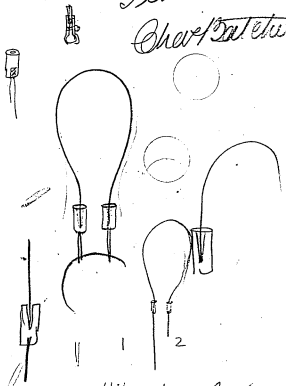
Make Lignum Vitæ Clamps

Ds:—

Turn them - Saw them - drill them and after carbon - using ream them out a little so as to clamp the loops about 1/2 of an inch



Chas Batchelor



Graphite Stamps for Carbons

Feb 4 1880 75
Chas Batchelor

2 pieces of Cocoa nut shell
cut $\frac{1}{10}$ long and $\frac{11}{100}$ thick
after carbonizing were
$\frac{44}{100}$ X oval $\frac{6}{100}$ one way
and $\frac{8}{100}$ the other

Before ·60 X ·11 circular — fracture glassy
After ·44 X ·06 and ·08 oval — breaks hard

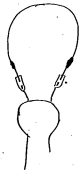
2 pieces Lignum Vitæ
Before ·60 X ·11 circular (fracture
After ·46 X ·08 circular (dense

2 pieces Iron Wood
Before ·60 X ·11 circular
After ·45 X ·7 a little oval
fracture dense - breaks easy

Carbonization:-

Made lamps of Manilla fibre and cocoa nut clamps — the clamps pushed onto the platina wires after carbonization

Afterwards made them with the platina wires set in the cocoa nut shell clamps previous to clamping — The wires leading from the glass were flattened out and two holes punched in it and the platinum wires from fibre threaded through ~~or~~ after this the flat platinum was flattened out clamping the wires tight



Chas Batchelor

282 | 42 | .22
1564
1560

42 | 282
282
282
5640
5640
6204

.019 | 19.
2.28
19.28
17.

Feb. 12 1880 80

Carbonization

Cocoa nut fibre shrinks by carbonization

Before 2.82 inches
After 2.10
.72 or 25 p/c.

Therefore Cocoa nut fibre shrinks in Carbonization $\frac{1}{4}$.

Tried thick and thin fibres

Chas Batchelor

Rice Straw shrinks by carbonization 12% in length and thickness

100 99 98 97

7/100 unit. 1/250 of ohm.

44
16
264
44
704.

33 / 704 (21 1/3 feet eq.
66
77
33
11.

/ 21 1/3
1/2 42 2/3
1/4 85 1/3.
1/8 170 2/3
1/16 341 1/3

96 95 94 93

21
25
105
16 / 5 25 / 33.
42
5 5
43
32
13.

2.5
2
5 0

2 ft 6 lb.

-8%

39)

1000 | 39

39 | 1000 (26
78
220

26 mm in an inch

16) 27 (1.7
16
110
93
79

1.7
1.7
119
17
2.89
1.7
1943
289
4.83

1.7
1.7
119
17

1.35
119
160

4 | 37.5
9
28

39.4) 1000 (25.4
788
2120
1970
1500

1.57
8
12.48

16 | 25.4 mm in inch
16
94
80
140

1.57
1.57
1099
785
157
2.4649

12.48
2.46
7462
4992
2496
30.6982 .06
7.1

cu cent = .06

1000 cu mm = .06

1 cu. mm

1 cu. inch =

2.46
1.57
17222
+1230
246
3.7622

$\pi \frac{D^3}{6}$

250 mm. π πD^2

π 250 = 250

3.14) 2500 (80
251 2

80 mm
80 mm
6400,000
6) 1,500,000
266 260

80
80
6400
6400

250 mm

20.5 mm

3.14) 2050 (65
1884
1660

144320 ?

65
65
325
390
4225
205
21125
8450
6) 866125
14432

139000

24
9
216

216
139000

216 | 139000 | 643
1296
9400
864
960

1
643

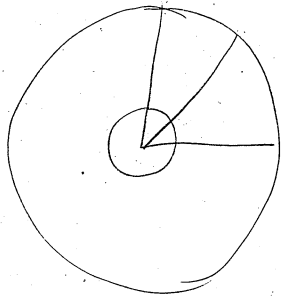
1
2

643
9
5787

Lamp.

Feb. 12th 1880 90

No. 649
650
651



Lamps. Feb 12th 1888

652 } Two small loop paper
653 } lamps made from $\frac{15}{1000}$ paper but of high resistance 303 ohms however they must be put on pumps to see whether they come down further -

Chas Batchelor

654 } Two large loops cut
655 } from regular mould but off the .015 M paper measuring 600 ohms - not being able to account for such high resistance we put them on the pumps Chas Batchelor

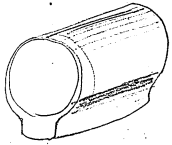
270
10
3000

Feb 13 1880 92

Size of Carbon cut from original former on the new uncalendered 13 thousand paper.

2.85 X .02 X .005

Chas Batchelor



Lamps

Small loops
656 } Made from paper .015
657 } uncalendered — and as they
are about 600 ohms we
put them on pump & see if they will come down

Feb 13th 1880
Chas Batchelor

658 Small loop — 300 R. — coated all over with Alumina finely powdered and mixed with Alcohol — put on with brush —

Feb. 13th 1880
Chas Batchelor

26/78

·014

·024

14 M

4/15

3·00
·28
2·22

2·22 X ·01

·01
3·1
·01
·03
·031
2·22
62
62
62
·06822

2

400
114
296

·14

4 in X ·014 would be 2·96 X ·01 = 100 ohms

·031
2·96
186
279
62
·09176

8 X ·014 would be right

·0145

21

~~80420~~ 14 M 20 M Rem. 100

·020
3·14
80
20
60
·062800
·00240

~~·025~~

0145

Lamps: Feb. 13th 1914 pm

659 Small loop made from ·015 Uncalendered paper — To be blown in large bulb. for experiment — High resistance —

Chas Batchelor

660- Bass fibre — 3in long ·014 thick nearly round Shrinks 26 % — Resist 1/8 ohms

Actual surface for lamp ·069 inch

Actual length 2·22 X ·01 round —

300 / 65·D / 0·15
30000
20000

200 / 1700 / 0·26
1700

223

Lamps

661 Cocoa Matting —
Before Carbonizing was
3·X ·028 X ·013
One cocoa nut clamp.
One lignum vitæ clamp.

Cocoa Matting shrinks in Carb.
Before Carb. 3·00 inch
After " 2·45 —
or about 18 %. Feb 13th 1880
Chas Batchelor

Bast fibre shrinks in Carb.
Before Carb. 3·00
After " 2·23
or nearly 26 %.
Chas Batchelor

300 | 5 x 20 | 69
300
2830

Kittool fibre shrinks in Carb.

Before Carb. 3.00 inch
After " 2.42 "
or about 19 %.
Chas Batchelor
Feb 13 1880

662 } Small loops cut from
663 } 10m Uncalendered paper
after pressing under
one ton pressure
Res is about 300 ohm.
Feb 13th 1880
Chas Batchelor

664 – Small loop – from pressed paper – about 300 ohms – coated with Zirconium Ox.

Feb 13th 1880
Chas Batchelor

This had a leak in inner tube and got no vacuum

665 } Same as 664 –
666 } Feb 14 1880 CB.

667 New pressed paper but high resistance

668 ~~New pressed~~ Old paper 6½ thousandths – R. 250

Experiments in Carbonization
Feb 18th 1880
Chas Batchelor

In our experiments with Bristol board we have been able to bring our loops both large and small to a resistance of 200 ohms using well calendered board of 9 and 6½ thousandth. As this board was known to be very impure owing to the clay, etc. and resins used in sizing we had some pure uncalendered paper made – This came to us varying in thickness from 15 to 70 thousandths – Large loops

made from the 15 thousandths measured from 600 & 800 ohms and small loops made from the 10 thoths measured 400 & 500 ohms. These high resistances we thought must be due to oxidization although we could not see it direct — the loops had not that peculiar steel gray color that the former ones had — this we attributed to the absence of that resinous matter that is used in sizing the board. We made a solution of resin in alcohol and soaked some

of the loops in it (a weak solution) but these were 1500 ohms - In this case they really looked oxydised although the tissue papers did not —

$1\frac{1}{2}$

We now put in 4 of the old style small loop and they came out 250 ohms showing that probably it is in the paper and not due to leakage in the moulds

We put the new paper under pressure but found not much difference —

We hammered the moulds so as to close the pores to prevent oxydising

3 loops brought from the hammered mould however measured 400 ohms

5 In the same mould that the old regulars came out of (250 ohms) we put 3 of the new paper ~~[illegible]~~ pressed and they again came out 450 ohms with tissue paper looking splendid — Carbons looking very black and dull as they always have done

6 Same mould as above and double ~~strength~~ of resin came out 400 ohms

7 Same mould again and doubled strength again of resin – came out beautifully straight – but had a resistance of 480 ohms

---

~~(3 loops new paper (pressed) & carbonized with carb in between of same paper pressed came out 275 ohms these were lamelled down by a plate of nickel –~~

~~275 ohms – I think the last on top~~

No 9 We now put 3 new (pressed) paper loops in with card between of same pressed paper (no tissue paper) and nickel plate to put on weight — These came out not very good shape but only 2.75 ohms

No 10. Three regular (new) pressed paper tissue paper — nickel weight — 325 338 440

I think the last on top

Hammered mould

No 11 Three new (pressed) paper with extra double diabolical strong solution of resin in alcohol — tissue paper — ordinary carbon weight

325 — 315 other broke

No 12

Three new paper (pressed
— tissue paper — ordinary
carbon weight —
Came out 320 to 340 —
Boiled them afterwards in
solution of Sugar in Alcohol
with little water — Put them
on gas heater again —
Owing to putting in new
tissue paper the sticky
loops would not allow it
to shrink properly and it
broke up the loops

try Another

No 13
Took a piece of uncalendered paper 10 thousandths and soaked in creosote and Tar. — Carbonized it —

14 Bottom loop soaked in Tar and creosote, bad looking 600 ohms

top loop soaked in sugar and alcohol
good looking (excellent)
142 ohms. make more

15 2 loops of regular paper
- tissue paper - Carbon
weight - put in fire
clay moulds - plenty of
tissue paper packed in
to keep it tight

16 3 Regulars for second boiling

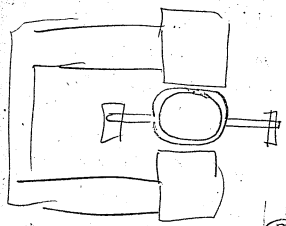
Lamps

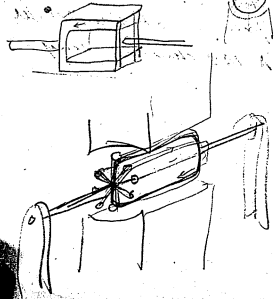
669 Old small loop made from 6½ M. – about 250 ohms – Smoked by Camphor.

670 Same as 669 but not Smoked

671 New small loop from pressed paper soaked in sugar R 142 ohms – gloss –

Chas Batchelor
Feb 15th 1880





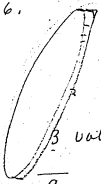
06
.06
.00036
4415
.80
144
144
.016020

1.60 feet,
80
8000

79
4
316.

turns.

316.

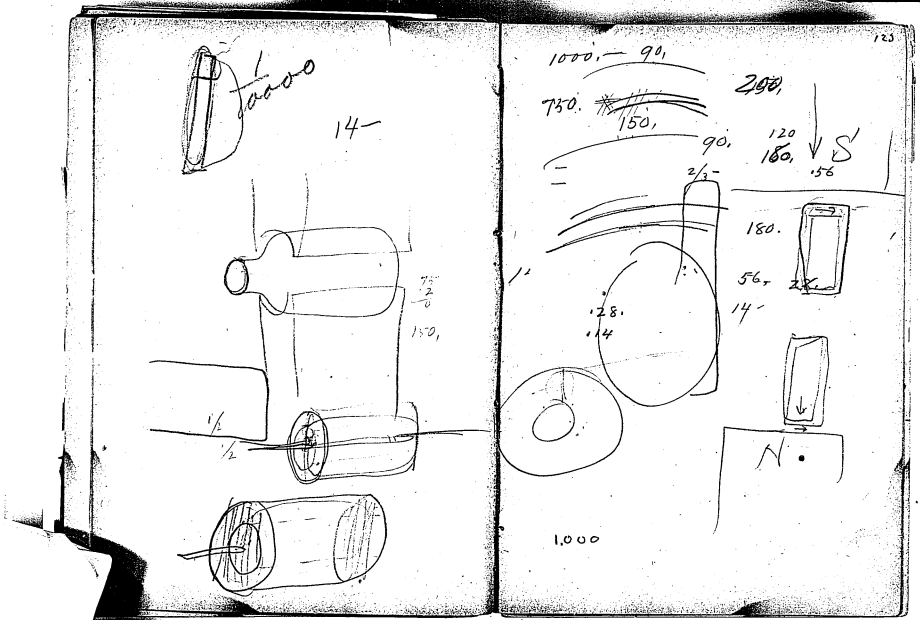


90 volt.) 316.) 3
270
46

3 volts,

9
44
396
2
792
2
1584
2
3168
2
6336
2
12672

1. ohm.
1/2
1/4
1/8
1/16
1/32


1000
14
75
2
0
150,
1/2
1/2
123
1000, — 90,
750.
150,
290,
90,
120
180,
S'
.56
2/3
180.
56,
14
.28.
.14
1,000
N.

Carbonizing Feb 16th 1880

Charred Cellulose

Exp 17 Tissue paper soaked in boiling sugar in alcohol and little water. part not dipped in sugar oxidized. sugar part good worth more trials between other sheets to prevent oxidation

18 A small loop of new pressed paper — the loop is unfinished and of first cutting — soaked in boiling sugar — dried — pressed from 13 M to 8½ M — — carbonized — Stuck badly to the tissue paper — Edison scraped it clean — Dense — Vitreous facture

Carbonization Feb 16 1880 120
Chas Batchelor

19 Small loops new paper — Boiled in olive oil — after pressing and cutting — Dull looking — Not oxidized — 860 ohms —

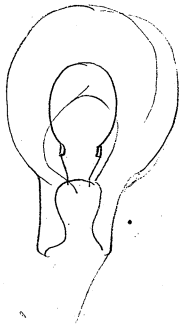
20 3 New paper loops — small size — pressed — soaked in sugar — pressed to .008 in — cut out — Carbonized — These had an ivory appearance befor carbo. — after — 113 ohms — shiny — stick badly to paper

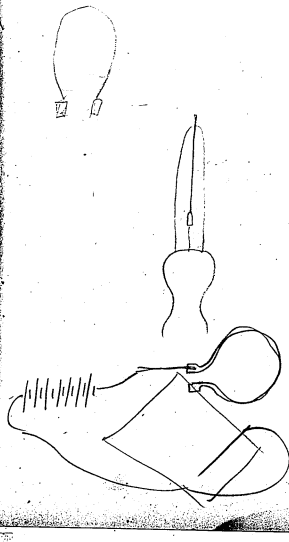
Feb 16 1880 17
Chas Batchelor

21 3 small loops cut from 15 m paper after pressing
see what resistance
330 ohms

22 3 small loops of pressed new paper – soaked in sugar solution – cut and dried slowly – carbonized
all broke by striking together

Feby 7 1880





$\frac{1}{3} =$

9 Expansions

6 = 41) 100 (.009 1 Litre

10

8,500

6

1 14000. 41

56,000 Ton 1.4 Q 4 mm

1 litre Q 34

7500 C

14 lb of water

8000 1 cwt in bath 1 ton

1 foot high

4-4. 2/2

16

9-3/5.

2.6

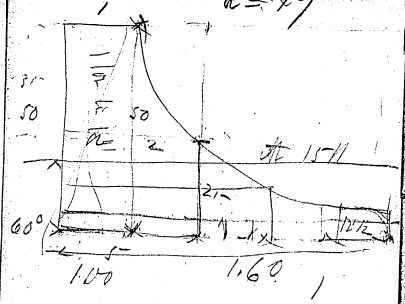
6 Expansn = 2.75 Divisions

1 lb of water to 1 lb of ice

= 5.875.000 =

16000. 9 volts 3/5

$R^2 = x^2 y$



260 /#

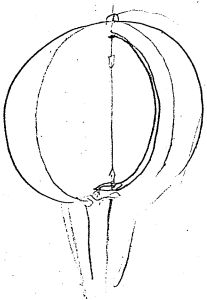
5.875 46 mills in 8

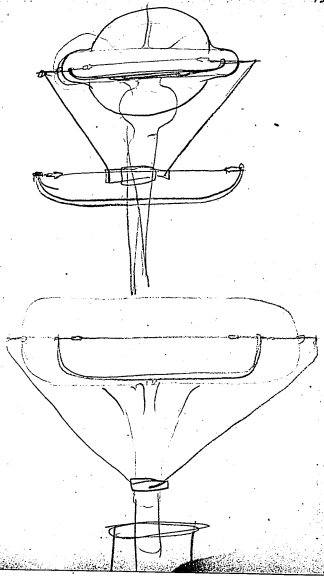
46
46
23
119 mills

C $h = 606.5 + .305 t$

F $h = 1123° + 305 t - 32°$

2.3 gm = 33





15.4
1.4
616
154
21.56 grains

1 liter 0 grammes

61.3 cu in 21.56 grains

61.3) 21.65 (.400 mg

61.3) 1430.0 (23
1226
210

.005

389
1600

5) 200
40
1600

1/2

16
16
6

360) 0100 0

360.) 0120 (.003

1 16) 100 (6 4 4 1 / 16
96
4

.0620
0600
14
2576
2576
3864
.00414736
00103684
3 4 8
414
103
307
.003234 2

.039

32342

.003

Lamps

672 } Small lamps with sugar
673 } See Carbonization Exp. ~~Fe~~ no 20 Page. 126.
Feb 14th 1880
Chas Batchelor

674 } Carbonization Exp.
675 } 23 aug 24 Page 134

676 } carb Exp.
677 } ~~#20~~ 25 aug 26
678 } Page 134
679 }

Carbonization Feb 17 1881 134
Chief Batchelor

23 3 loops - small -
24 sugared before cutting

24 all stuck together.

25 3 loops each small
26 sugared after cutting

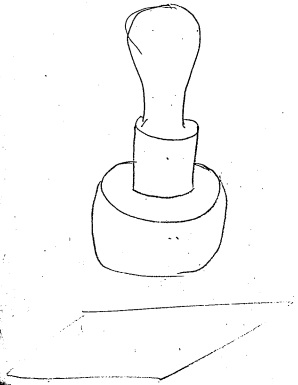
27 — Pieces of Bast fibre —
— Soaked in boiling Sugar —
— Bulky! — very dense — boiled
in Sugar again — Carbonized —

Carbonization Feb 17 1880 136
Chas Batchelor

28 - 2 Rings of Cocoa nut

29 Small loop - Sugared before cutting - put in between 2 nickel plates — not cut off at bottom — came out

- - very flat and nice



Carbonization · Feb 18th 1880 137

Chas Bal otrector

30 Same as 29 only I cut the bottom so as to let two ends free

Better, put in again — good looking

31 Same as 30

Came out very good

Not quite perfect in shape

32 3 loops (small) old style put in regular way — heated on gas jet only

For Dr Hand test for Hydrocarbons

Lamps Feb 18th 1880

Charbatchets

680 Cocoa nut Shell —
— too thick — 17.3 ohms

681 1 Small loop Exp. Carb.
No 29 page 136
93 ohms -

682 Same as 681 — Carb. exp. 30
683 small " " " " 31

Carbonization Feb 19, 80

Martin H. Force

33.

Ten strands of Jute Fibre Soaked in Sugar, placed in bottom of mould Six strands on top layer

Shrunk together

(34)

Small bunch of Jute Fibre (Plain)

Came out beautiful

Carbonization Feb. 19. 1880

Maitland & Forrest

35 } Regular Paper (new)
36 }
37 } Cut in squares of an
inch. Put in regular way
heated on gas jet only
For test by Carl for Hydrocarbons

38) 3 loops of Jute Fibre. several
strands in each loop.

39 one Bast fibre loop 4" x .014.

Lamps

684

685

686 —

687 = Bast fibre — 4" long × ·014 thick
— Showed be 100 ohms —

Carbonization Feb 18th 1880

Chas Batchelor

40 one bunch of very fine Jute fibres

41 One large ring of Jute fibres
One small ring of Jute fibres

42 One large ring of plaited Jute fibres

43 Bass fibre 5" X .014 ind.

Carbonization Feb 18th 1880 143
Chas Batchelor

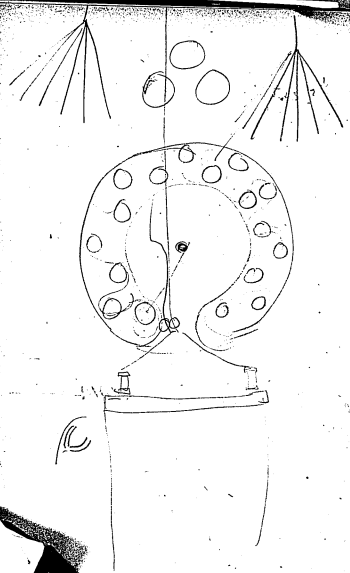
44. Jute fibre — 3 strands plaited by Hipple —

---

45 Small loops — same as 32 —
Had treated them with Nitro Muriatic acid —
all busted — try again —

---

46 } Bass fibre — 5 mel × ·014 —
47



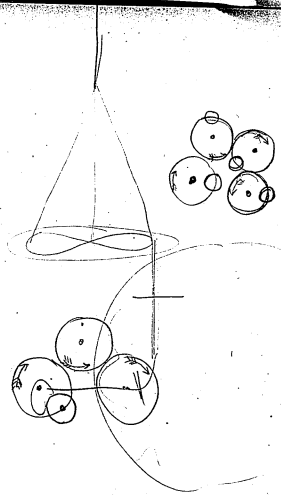
Carbonization Feb 18 1880 1424
Chas Batchelor

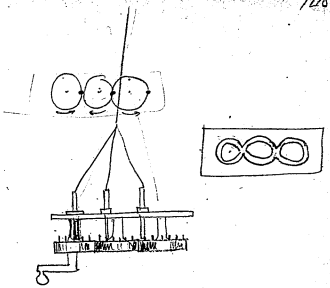
48 Jute fibre – Plaited 3 strands by Hipple

49 Me Bast fibre 5'''X·014

50 Jute fibre – 3 strands twisted together by McKenzie –

51 Jute fibres – 3 plaited –





Lamps

Feb 18th 1880
Chas Batchelor

688 – Bunch of fine Jute fibres see Card. Exp. 40.

689 Bunch of fine Jute large Card. Exp. 41

690 Small bunch of fine Jute Card Exp 41

691 Large bunch of Jute fibre plaited 3 strands —

Lamps

692 Bast fibre — 5" X ·014

693 Jute fibre — plaited 3 strands
695 Twisted are in Clamps
693 Twisted

694 Bast fibre — 5" X ·014 —

695 Jute Fibre 3 strands twisted together by Mc Kenzie

Carbonization — Feb 18th 1880
Chas Batchelor
148

52. 3 large loops cut from 10 thousandth paper and soaked in weak solution of sugar

53 Same as 52 —

54 2 Manilla hemp loops of 6 strands each of ·0015 thickness

55 2 large loops of 15 thousandths paper soaked in Sugar (thin sol) before cutting — no pressure at all — about 167 ohms

Carbonization — Feb 18 1910 149

Chas Batchelor

56 — A lot of plaited Jute fibres different thicknesses —

57. 5 large coops from 10 M paper — sugared in weak solution — before cutting — no pressing whatever —

58. Bass fibre — 5" X '014

59 3 large coops — 10 thousd paper Sugared in weak solution — before cutting — no pressure —

Lamps

Feb. 19th 1884 150
Chas. Batchelor

696 Bast Fibre..
5 inch × ·014

697 Jute fibre – 3 strands plaited

698
699
700
3 large loops – uncal. paper
·010 mil thick – soaked in sugar
weak sol. before cutting –
Resis. after Carb. 169 ohms

701 large loop – sugared in weak sol –
no pressure – put in large globe
tested by Francis –

Carbonization

60 3 unwaxed with 8 large loops in

61 One Bast fibre – 4 X ·014
this I boiled in water and made it set itself in position on cooling — so there is no strain in carbonization —

62. Plaited jute fibres —
soaked in thick sugar where the clamp gripped it

Lamps

Feb 25th 1880 152

Chas Batchelor

702 Bast fibre 5 X .014

703 6 Manilla fibres .002 thick — not twisted, but laid straight together —

this

704 } Bast fibre — 5 X .014
705 }

706 — 717 inclusive
Sugar cards about 200 ohms.

Carbonization Feb 20 1880 153

Chas Batchelor

63 – Jute fibre – plaited – platinum wires fastened to jute by tying jute round – these ends boiled in sugar –

64 Bass fibre – 5 × ·011 soaked in sugar – shaped before carb.

65 Underneath – loop of plaited jute – soaked in sugar – all over

On top – loop of straight fibres of jute dipped in sugar and drawn straight through the fingers

Carbonization Feb. 20th 1880 137

Chas Batchelor

66

Bottom – Jute fibre plaited – wet and shaped by heat – ends cut off and sugared –

Middle – Thick plaiting of Ramie in ring – ends sugared – – Busted – stuck in mould

Top. – Thin plaiting of Ramie – sugared all over – – busted – stuck in mould –

---

67. 3 large loops – sugared with new sugar solution – made from 10 thousandth paper –

168
209

Carbonization Feb 22nd 1880 153

~~Chas Batchelor~~

68. 3 loops-large - old sugared solution -

69. 3 loops large - new sugar solution

70 a small chip of rich bark

71 3 moulds of large loops - new sugared solution -

Lamps

Feb 22nd 1880 56
Chas Batchelor

718. Jute fibre - plaited - platinum wire fastened to jute by winding round with jute - the ends boiled in Sugar - Carb. 65 -

719 Carb. 64. Bass fibre - 5 X .011 - soaked in Sugar - Shaped before carbonizing -

720 Carb. 66 Jute fibre plaited - wet - shaped by heat - ends cut and sugared -

Lamps Feb 22nd 1880

Chas Batchelor

121 Cash 62 — Planted jute fibres — soaked in thick sugar where the clamps catch it

122
123
124 } large loops cut from '010 — & sugared in standard solution

125
126 Two high resistance large loops made from sugar sol No 0 —

126 broken by glass blower

Carbonization Feb 22 1880 154
Chas Batchelor

72 Bast Fibres – thick – for investigation –

73 2 Bast Fibres – held in – paper clamps – and clamps engaged

74 1 Bast Fibre – Paper ends – ends soaked in sugar – clamp held in carbonizing chamber by piece of carbon slotted –

Chronization Feb 22 1880 159

Chas Batchelor

75 1 Bass fibre — paper ends soaked in sugar —

76 Four bass fibres. Spiral

77 March — 3rd 1880
1 high resistance loop coated with sugar and plumbago Solution —
36 ohms resistance

78 Piece tinfoil coated on one side with thick Sugar and plumbago —

Heat Moulded for Papers
Feb 22 1880
Chas Batchelor

Sugar Solutions Feb 22 1880
Chas Batchelor

No 0
1½ oz Troy Sugar
140 cc Alcohol
47 cc Distilled Water
With 10 thousandth paper this makes carbons of 350 - 400 ohms.

No 1
1½ Troy oz Sugar
70 cc Alcohol
22 cc Water (Dist)
first cot 268 & 312 = too slow heat

Sugar Solutions Feb 22 1880 161

Chas Batchelor

No 2 1 ℥ Troy Sugar
70 cc Alcohol
22 cc ~~Dist~~ H_2O

3 2 ℥ Troy ℥ Sugar
70 cc Alcohol
22 cc Water = Very thick on cooling

Lamps. Feb 23 1884
Chas Atchelor

727 Lab Exp. 74 — Boat fire —
Paper was soaked in thick sugar —

728 Large loop — New Sugared Sol.
high R, 312 ohms —

729 Large loop — Sugared with No 2
solution —

730 One large loop — coppered ends

Sugar Solutions

4 $1\frac{1}{2}$ oz Sugar
70 cc Alcohol
22 cc ~~H_2O~~ Water
Water put in first the tube and alcohol added
— 230 R—

---

5 $1\frac{3}{4}$ oz Sugar
70 cc Alcohol
22 cc ~~H_2O~~ /
— 157-169-R—

Sugar Solution

6 No 2 cards left in
20 minutes

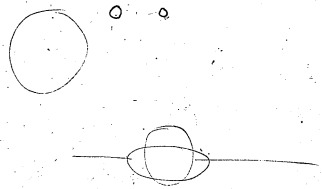
---

7 1 Oz Sugar
50 cc H_2O
— loops boiled 25 minutes - blotted
between blotters —
190 - 197 - 177 - 200

---

8 2 Oz Sugar
50 cc H_2O
blotted after.
#120 -

H Low



731 } Large loops sugared wort
732 } No 5 Solution of sugar

733 Large loop. No 4 Sugar Solution

734 } Large loop — soaked in No 4
735 } Standard Solution —

736	746	758	769
737	747	759	770
738	748	760	771
739	749	761	772
740	750	762	
741	751	763	
742	752	764	
743	753	765	
744	754	766	
745	755	767	
	756	768	
	757		

Bass Fibre — Feb 24 1880 166

Chas Batchelor

make clamps so:—

Take bass fibre and drill holes so:— Bring the whole up in Vacuo and then cut off into clamps putting fibre in so:—

It may be better to place the platinum wires in the holes before carbonizing

2 X 2 X 44 ÷

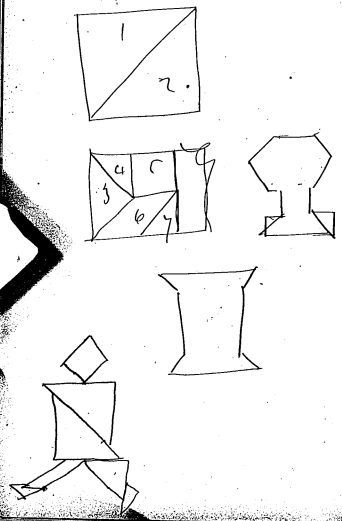
To be made immediately

200 large loops sugared in Standard Solution

200 Small loops cut from 6½ m sugared and pressed

100 Manilla fibres of 8 m diam and long

Have Tuesi make moulds without cover so as to work in Vacuum



Let to see why some cabins are greater resistance than others in same mould

March 3rd 1880

Gs in mould

Top. 1	2	3	4	5	Remarks
300	290	255	265	255	
204	216	300			top flat – 3 corrugated – 2 & 1/2
249	310	324	—	—	all corrugated – 3 badly –
Broken	260	299	—	—	all flat.
206	208	230	—	—	all equally uneven –
	208	240			bottom most uneven
234	176	255	—	—	bottom uneven
202	192	234	—	—	1 & 2 flat, 3 corrugated
192	236	239	small loop		Bottom most corrugated
224	266	260	small loop		" " "

Lamps.

773, 774, 775 — large Carbon soaked in Edison's Sugar Solution
Paper pressed first — soaked — and pressed afterwards

776 — large Carbon — old solution Sugar (weak) — high resistance about 400 ohm — Coated with strong solution of plum-bago and sugar — Sugar coating not previously carbonized —

777 — 713 — 711 — One large loop — Edison new Sugar solution

Carbonization

79 – common paper with plumbago and sugar solution spread on both sides – dried – and cut came out all broken up (should have been put in without tissue paper)

80 = three large loops – Edison's sugar solution

81 =

82 5 thick tissue sheets – – painted on both sides with plumbago and sugar – and stuck fast together in cutting

83 – 22 tissue papers cut together

Lamps.

778 Old high resistance loop
— plumbago and sugar solution
— and carbonized (?) — Resis. 35 ohms
Bunsen pump — inside glass
broke —

779
780
781
782
783
784
785
} large loops
Edison's new sugar solution.

786 24 sheets tissue paper
cut together R 160
Glass cracked in pump
Carbon broke afterwards

241160 20
20

161
28
1600
3600
28 / 78 2
36400

1620
227
2274
3640
3 6 4 0
4 1 3 1 4 0

1 36400
5 1820
4 910
8 455
16 227

18 227 × 1820 = 413140
227 + 1820 = 2047

413140 | 20
4094 | 374

Carbonization

84 24 tissue papers cut together
R 160 lamp 786

85 3 small loops cut from
86 15M paper pressed to 7M

87 22 Sheets tissue cut together
Bustet

88 18 Sheets tissue cut together

89 18 Sheets tissue cut together
R. 285

90 18 Sheets tissue cut together

Lamps

787, 788, 789 — ~~Electric Carbon~~ — small loops cut from pressed .015" paper

790 — large loop. — Carb. No 89 — 18 sheets tissue pressed before cutting R 285

791 — small loop. Carb No 96 R 270 — 12 tissue sheets pressed together before cutting —

792 — Large loop — 18 sheets tissue pressed and cut together — R. 254

793 3 small loops carb No 86
794 R 260. 260. 2241 cut from .015" in paper
795 Pressed to 7 in.

Carbonization Mcl 3rd 1880 175

91 18 Sheets tissue cut together after pressing

92 Tinfoil coated with plumbago and sugar and tissue paper stuck to it – carbonized between two plates – one recessed
Came out all broke –

93 18 Tissue papers – pressed together – large drop
R. 357 to high

94 12 Tissue paper – pressed – small drop.

Carbonization

95 = 9 tissues papers – cut = in small loops – tissues pressed together

96 12 tissues papers – cut together – small loop – pressed before – cutting –

97 18 tissues – large loop – pressed before cutting – weighted during carbonization –

98 two moulds of 3 small loops 15 M paper (pressed and cut) uncalendered

Lamps Mcl 3 1880
Charlotte Chels

~~Lamp Cut~~
~~793 18 tissue papers~~

796 small loop cut from
797/5 m paper pressed to 7 m
carbonizing 86 K 285
86

---

798. Carl. 101 –
Small loop. (208 R.) 18 tissues
cut and pressed together

---

799 Carl. 991 (256 R)
12 Tissues cut together after
pressing

---

800 Carl. 103 (234 R)
Large loop
24 tissues pressed and cut together

Carbonization Mcl 4 1880 Charlestown

99 12 tissues - small loops

~~100~~ 258

100 18 tissues - large loop
cut together pressed before cut

101 18 ~~tissues~~ 108 small loop
102 cut together Pressed ~~fe~~ before cut
102 Broken mt a very out of order

103 24 tissues large loop
104 cut and pressed be fore cut
105

106 18 tissues small loop
cut together after Pressed

all worked did not fuse

Lamps Mcl 4 1880 180
Chas Batchelor

801 (Card. 100) N 270.
18 tissue cut and pressed together

802 Card. 105 — 24 tissues
cut and pressed together —

803 Card 104
same as 802 -

804 (Card 92)
5 Sheets tissue paper coated
both sides with plumbago
and sugar and all pressed
together

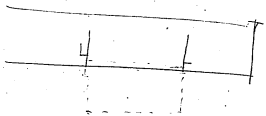
Carbonization March 4 1880 181

107 } large loop 24 tissues
108 } 107 540 ohms resistance

109 1 large loop of 22 tissues —
2 small loops 18 tissues —
1 carbon weight and piece of nickel for extra weight.

110 1 large loop of 22 tissues
1 small loop of 18 tissues

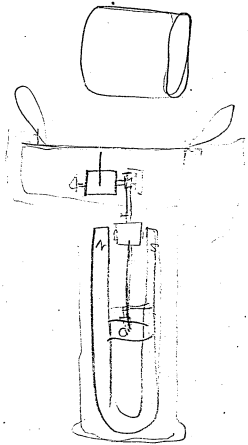
111 1 large loop of 22 tissues



Mch 4 1880 (182)

Make thin bass fibres coated with plumbago and sugar and copper plate the ends.

Have get copperplate the carbons



Carbonization – March 4 1880 183
Shorpsbotchen

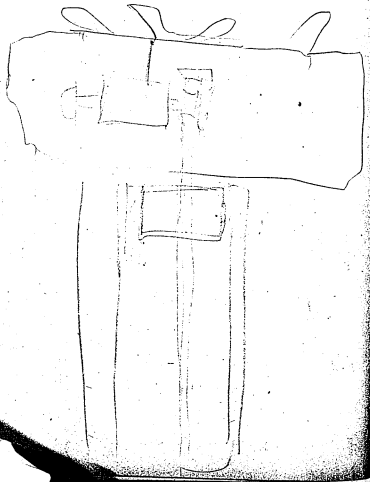
112 3 small loops of 15M uncalendered paper pressed & 7M

113 3 large loops 22 tissues

114

115 2 moulds of Ramie fibres

116 2 large loops – of 22 tissues – pressed and cut together



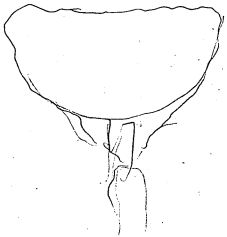
Carbonization March 5 1880 184

117 2 small loops of 12 carbon papers each

18 2 small loops of 18 tissues each — pressed and cut together

119 3 small loops of 15m paper uncalcined — pressed and cut together —

120 1 loop of (large) tissue papers 12 in number — with thin plum bags and sugar solution in between each — all broiled



Carbonization MCL 5 1880 186

121 Ramie fibres ~~together~~ ~~together~~ wet and drawn together

122 Manilla fibres about 12 together

123 2 Bass fibres coated with Plumbago and Sugar.

124 Jute fibres stuck together by wetting them in the mouth and drawing through the fingers

806 This I found broken in Glass house I think by not washing off the copperplating solution it has ~~eaten~~ blistered out where the deposit ended.
C.B.

Lamps Mch. 6th 1880 187

805 Small loop copperplated 15m - paper pressed to ym clamps heated on pumps and busted

806 Small loop — copperplated — '015 paper pressed to '007 — broken in Glasstower

807 Small loop - copperplated — '015 paper pressed to '007 — Small crack on inside globe cannot get vacuum

808 One fibre of jute with coppered end

8000 ohms

100/800
500
20
80

Cartonizations

125 3 Manilla fibres coated with Plumbago and Sugar
So badly out of shape that could not use them —

126 2 Jutes ~~fibres~~ of a number of fibres each set in Card holders

127 1 Full round fibres of wire grass — and
2 half round fibres of same

128 3 fibres of ~~brown strong of bottom fibre brought~~ by Dad
Palmetto leaf fibre —

Carbonization = March 6th 1880 189

129 Palmetto leaf fibres –

130 2 Moulds of 3 small loops each – 015 uncal. paper soaked in NH_4SO_3 and pressed with hard pressure

131 Palmetto leaves split to width Digested try again

132. 4 small loops – uncalendered paper soaked in NH_4SO_3 & pressed –

133. lot of fibres taken from stuff from Palmetto leaf. that looks woven –

Lamps

809 } 2 small loops — ·015 uncal. paper pressed to ·007 — ends.
810 } copperplated

811 Manilla fibre — ends copperplate
812 — Cat. exp. 122 —

813 2 Small loops ·015 uncal. paper
814 pressed to ·007 — ends copperplated —
815

816 Jute — (fibres) Number —
(Cat 126) Coppered.

134 24 Manilla fibres ·004 thick
-picked - perfect.

135 2 threads in platinum
clamps.

136 large loops - treated with
phosphorous

137 4 moulds of small loops
made from uncal. paper ·015
pressed to ·004 after soaking in
NH_4SO_3

814 Bass fibre coated with Plumbago and Lega — (Carb. exp. 123) Coppered —

818 } Manilla fibres — coppered —
819 }

128
820 Jute fibres stuck together
821 by weighting them in the mould
822 and drawn through the fingers
carb 124

0133
823 } Palmetto leaf carb 133
824
~~825~~
828

·04

8 / ·20
/ ·025
·050

16 cells. ·2

2 cells of 8. =

Mch 6th 1900
Chas Pettchela

826 Wire grass – Part. 127 –
– copperplated – very brittle
– Busted at top soon as put on –

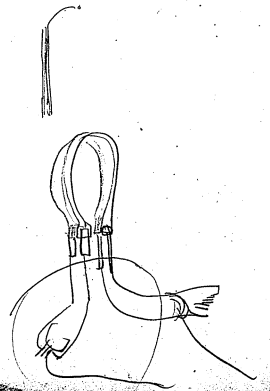
·050

Part. 130
Small loops – ·015 paper soaked
in Sulphate Ammonia pressed
& ·001 – coppered
gone up
heated 10 minutes at 1 gas jet

827
828
829
830
831
832

833. Palmetto leaf fibre –
– coppered –

Ocl



Carbonisation MCL 1880

138. 2 fibre (Manilla) together but kept apart

139 Moulded of '015 uncal. paper soaked in Sulph NH4 and pressed to 007 —

140 2 Moulded of '015 uncal. paper pressed to 007 —
These must be treated with Hydrofluoric acid

for further Carb. Exp
See Book 5.

6X6X44 ÷ ·1 ÷ ·05 = ~~·75~~ ·15

36
264
1584 + ·15 =

·15 | 1584·00 | 8 | ·20
| 1056·00 | ·020
3520 | ·51

8X8X44 ÷ ·05 X 4 ÷ ·05 = ·25

64
2816

·25 | 2816·00
| 1130
453
2265

4X4X44 ÷ ·025 ÷ ·05 = ·1
·05 ÷ ·05 = ·1

76
264
44

·03 | 704·00 | ·1 | 704
| 2330 | 3520
783
1566

Lamps

Card 134
834 Manilla fibres – about ·004
835 – Coppered –
836
837
838

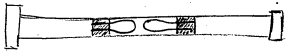
Card 134
839 Small cork uncal. ·015 paper
840 Soaked in Sulphate Ammonia and pressed ·004 – coppered

↓

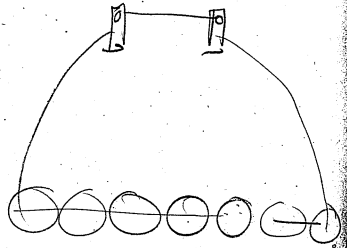
Cracked in glass (inside) burst in 5 minutes

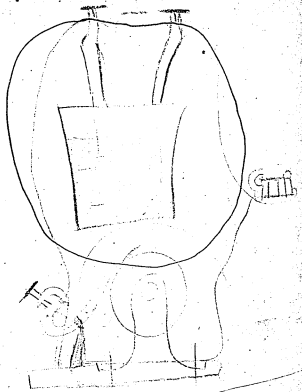
---

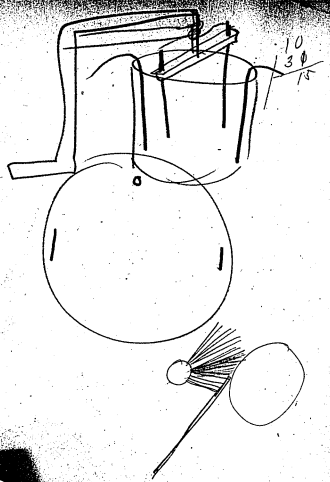
for further Lamps see Book 54



Ho rubber disk







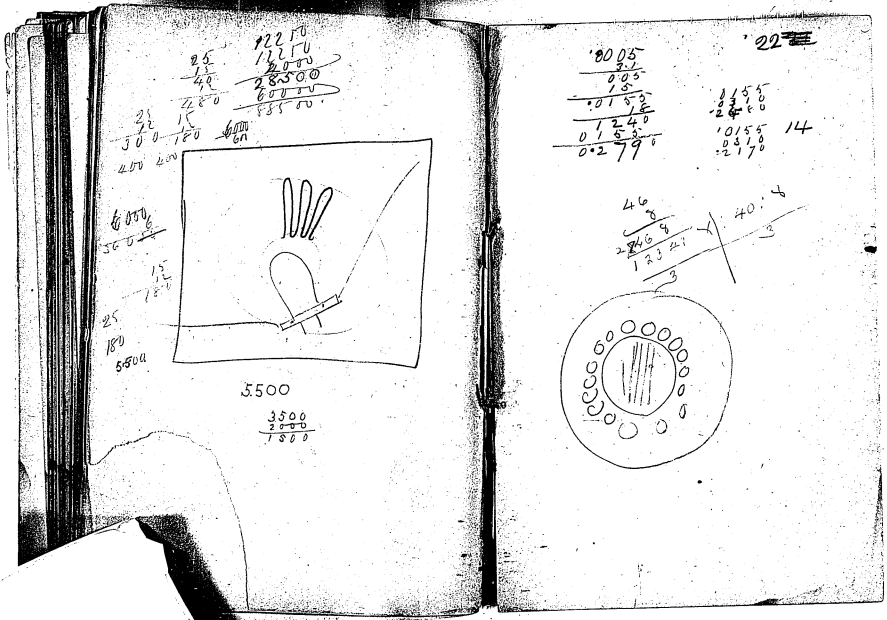
10
3 ϕ
15

$$W = \frac{5334 \times HP}{V \times C} = W = \frac{5334 \times 5}{250 \times 1.25}$$

250 · 125

625
5 1 25

JNT / 26670 / 84
2 r 200
14700


5500
3500
2000
1500
22
14
40
8
3

Menlo Park Notebook #71 [N-80-01-03]

This notebook has no dated entries but was probably used in 1880. The entries are by Edison and relate to published articles about chemistry, geology, and metals. Some articles are noted as being from the 1850 and 1870 editions of the Annual of Scientific Discovery. The label on the front cover is marked "Note Book." The book contains 231 numbered pages. Pages 14-231 are blank, except for a few doodles on pages 176, 182, 187, 196, and 229.

Pages not filmed: 14-231.

No 71

LIBRARY OF THE

BOARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

From Library

144 Broadway N.Y.C.

Nov 1, 189..

That substance which gives out the greatest heat or energy in combining with another body requires the most energy to decompose it.

Grove says that he doubts that absolutely pure water has ever been prepared as it cannot be made by boiling to give up its nitrogen gas dissolved therein,

At a high heat platinum is porous to Hydrogen.

FROM THE LABORATORY OF
T. A. EDISON,
MENLO PARK, N. J.
U. S. A.

Sir Roderick Murchison lays down as axiomatic that the most auriferous rocks are of the Silurian age, That a certain geological zone in the crust of the earth is auriferous at all.

Gold he says have never been found in any stratified formations composed of secondary or tertiary deposits but is in crystalline and palæozoic rocks or in drift from these rocks. The most usual original position of the metal is in quartzose veni-stones that traverse altered Silurian slates, frequently near their junction with eruptive rocks over

Sometimes it is however partially diffused rocks of igneous origin — from this it appears that volcanic eruptions in connection with Silurian rocks, are to be regarded as the origin of gold formations, which of California contradicts these assertions — says Silurian or Devonian fossil west of the 116 Meridian, indeed of all strata found to silurian rocks but with the exception of Auriferous — in general there is gold in metamorphosed rocks which are Silurian

Glass (crown) used in Lighthouses —

Silicic acid —	72·1
Soda	12·2
Lime,	15·7
alumina & fe oxide	Trace —

In Birmingham its made from following mixture,

	cwts	quarts	lbs
Frenchsand —	5	—	
Carb Soda	1	3	7
Lime	0	2	7
Nitrate	0	1	0
Arsenious acid	0	0	3

Experiments in O Hydrogen light 1840
conducted in London proved that Zirconia
inferior to Lime, (perhaps impure) but it was
permanent. Magnesia cylinders took
longer time to heat to white heat & took
longer to cool hence higher specific
heat or rather poorer conductor perhaps
on account lightness. A native
Crystal of native Zircon, retained its hardness
after a great deal of abuse. Vitrification
(true) could only be observed under
lenses.

another account says that magnesia
does not equal lime in power of
resistance, with pressure of 3 inches
on gas they were rapidly eaten
away & moreover split by action of
gas — perhaps they were not
pressed enough & were split by
aqueous vapor in power expanding

Intense Light obtained by causing Oxy Hy gas to play upon Chloride of Titanium, or Chloro-Chromic acid –

another H and Charcoal maintained with Chloride Magnesium.

another – Cylinder of hard compressed Titanic acid, Magnesia & Carb magnesia

Graham states that red hot Palladium absorbs a quantity of Hydrogen before it commences to pass it through

Palladium enlarges after absorbing 900 times its volume to $\frac{1}{20}$ to $\frac{1}{25}$ its volume: in this case Hy is reduced to $\frac{1}{19000}$ its former volume: the weight of H thus absorbed is $\frac{8}{10}$ to $\frac{9}{10}$ that of the weight of the Palladium: to compress H to this extent would require a column of Hg having the diameter of two mt Blanc + 3 times the height –

Peroxide of thallium, may be set on
fire by the faintest electric spark
surpassing. Equal parts Chlorate
Potassium & black sulphide antimony
to prepare; Annual of Scientific Dis
1870. p 198 —

To make Molybdenum & chromium
see same p 223. to make Uranium
p 225 —

Platinum found in Quartz with gold
in Scotland. it not magnetic
like that from South America;

Gold ocean $710 per ton in
Farm of Samuel Elliot
Montgomery Co Maryland
— 1840. A Sc Dis p 256

Vanadium Excess in
Copper ores of Lake superior
A Sc Dis 1850 262, it
occurs in such a way as
to lead to inference that it
will be found in large
quantities

Zircon - Gadolinite &
Yellow Obsidian increase
their density by heat

Menlo Park Notebook #72 [N-80-03-31]

This notebook covers the period March-May 1880. Most of the entries are by Charles L. Clarke. Much of the book relates to the development of generators, including the jumbo dynamo. There are notes, calculations, and drawings of shafting and belting for dynamos; calorimeter tests of dynamos; and notes on jumbo dynamos for the Pearl Street central station, including a memorandum on questions to be asked of Charles T. Porter, whose steam engine was to be used for the jumbo. Also included are notes by Clarke on Henry Rowland's report on the electric light, draft letters by both Edison and Clarke in response to the American Machinist's article on Edison's dynamo, and a report by Clarke on Sidney H. Short's telephone. The label on the front cover is marked "Clarke." The book contains 280 numbered pages and has been used in both directions.

Filming order: pp. 1-201, 275-210 [in reverse page-number order], 272-280.

Blank pages not filmed: 202-209.

X E-172 N-80-03-31

Blank

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A B C

A - B = a

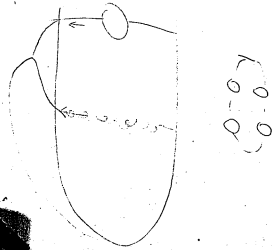
B - C = b

A - C = c

(A - B) + (B - C) = (A - C)

a + b = c

a - c = a - c



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38%
10%

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720 — 1,0857
73 — 1,0877
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000689

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$42\frac{1}{2}$
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$4\frac{1}{2}$
3
$7.8\frac{1}{2}$
$1'11\frac{1}{2}''$

$7\frac{1}{2}$
$6\frac{1}{2}$
$4\frac{1}{2}$
17
$\frac{3}{8}$
$\frac{3}{8}$
35
$\frac{3}{8}$
1 5'
41

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$35\frac{1}{2}$
2 $\frac{1}{2}$

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170224
191502
21278
233738 83

21278
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85112
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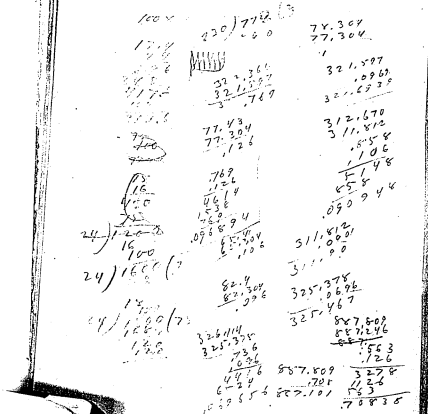

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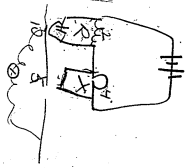

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Kings Treatise on the Science and Practice of the Manufacture and Distribution of Coal Gas, Edited by Thomas Newbigging. Vol. I

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0.2383701
1.5911166

410 0.2692093 1.8587
0.2439854
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420 0.2749103 1.8830
0.2495264
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430 0.2804190 1.9073
0.2550351
1.6083416

440 0.2859172 1.9316
0.2605333
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450 0.2913689 1.9560
0.2659850
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460 0.2965[illegible] 1.9807
0.2721948
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470 0.3022010 2.0054
0.2784271
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500 0.3179380 2.0794
0.2927141
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365 0.2431869 1.7506
0.2179630
1.5711695

375 0.2490760 1.7745
0.2238521
1.5767786

385 0.2548863 1.7984
0.2296624
1.5825889

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0.2354198
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1.5[illegible]96

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57
54
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117

5)1620
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35-6

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1

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9)2340
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243
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2251
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2370
3555
119.5
2385
3555

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239

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9)1940
2

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125

378
5
9)1890
210

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278
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9)370
135

263
270
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135

9)1300
14

)64431

1040)69684(67
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7284
7280

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6480×
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6310

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7840×
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224
180

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81200×
5476
4640
5360
5120

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0773

.0206

1240)98067(799
86800
12267
11160
11070

1280)105.565(8247
102400×
3165
3150
6500
5120
9300

.0206
.0219
.0232
.0245
.0258
.0271
.0284
.0297
.0310
.0322
.0335
.0348
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.0374
.0387

1320)113.263(8.56
105600×
6663
6600
6300

1360)119.779(876
108800
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9520
8500
8160
3400

1400)126.287(902
126000×
2870

1440)133.603(928
129600×
4003
2880
1280

1480)141.125(954
133200×
7925
7400
5250

1520)148.860(979
136800
12060
10640
14200
13680
5200

1560)156.798(1005
1560
7980

1600)164.949(103
1600××
4949

1640)173.292(1056
1640××
9292
8200
10920

1680)181.848(1082
1680×
13840
13440
4000
3360
1400

1720)190.611(1108
1720××
1861
1720
14110

1760)199.579(1134
1760××
23 57
189 1760
1 59 79
1 52 80
000182.5 6990
31 8716
10550
16225
7300
16225
5475
5 72

1800)208.754(1159
1800×
28 75
1800
12754
9000
17540
16200
1340

1840)218.048(1185
1035000
394 2604
394 2604
980868
1013237.68 total
1.037.00

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.0026
156
52
.000676
.000169
31.416
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169
676
169
507
1000530.931

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432
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1152
780
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600
504
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210
300
280
20

0.5859230
78.4
0.5859308 54

.05-15
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.072
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144
504
4,00 5,0 4
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7776
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3888
.00467 51136

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325
390
4.0042 25
1687,0,756
3,0,75
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10 1 6
4,32 4
4,0 1 6
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.0031 7 5296

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$\bar{4}.8290425$	$\bar{3}.9391140$	$\bar{5}.5246589$
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$\bar{3}.1316394$	$\bar{3}.9218964$	$\bar{5}.5463575$
$\bar{3}.8864907$	$\bar{2}.5877110$	$\bar{2}.1903317$
$\bar{3}.3065599$	$\bar{2}.0017802$	$\bar{3}.6094009$
$\bar{2}.0128372$	$\bar{3}.1139434$	$\bar{2}.2253093$
$\bar{3}.4269064$	$\bar{4}.5280526$	$\bar{5}.6293785$
$\bar{2}.1105897$	$\bar{3}.4149733$	$\bar{2}.2552725$
$\bar{3}.5246589$	$\bar{4}.8290425$	$\bar{3}.6693417$
$\bar{2}.1903317$	$\bar{3}.5910646$	$\bar{2}.2855573$
$\bar{3}.6094009$	$\bar{3}.0051338$	$\bar{3}.6296265$
$\bar{2}.2552725$	$\bar{3}.7160033$	$\bar{4}.9542625$
$\bar{3}.6693417$	$\bar{3}.1300725$	$\bar{4}.3653777$
$\bar{2}.3138672$	$\bar{3}.8124134$	$\bar{3}.2304489$
$\bar{3}.7279364$	$\bar{3}.2269826$	$\bar{4}.6485781$
$\bar{2}.3654880$	$\bar{3}.8920246$	$\bar{3}.4149733$
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$\bar{2}.4116197$	$\bar{3}.9542425$	$\bar{3}.5314789$
$\bar{3}.8256889$	$\bar{3}.3683147$	$\bar{4}.9455481$
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$\bar{4}, 6020600$	$\bar{3}, 7781513$	$\bar{3}, 5910646$
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$\bar{3}, 0051338$	$\bar{4}, 7564919$	$\bar{4}, 5280126$
$\bar{3}, 6334685$	$\bar{3}, 4149733$	$\bar{3}, 2041200$
$\bar{3}, 0475377$	$\bar{4}, 8290425$	$\bar{4}, 6181892$

George Carman

53

$\bar{3}.2552\cancel{7}2\cancel{3}5$	$\bar{3}.1139434$	$\bar{4}.9542425$
$\bar{4}.1683117$	$\bar{4}.5280126$	$\bar{4}.3683117$
$\bar{3}.3222193$	$\bar{3}.1760913$	$\bar{3}.0413227$
$\bar{4}.7362885$	$\bar{4}.5980605$	$\bar{4}.9585119$
$\bar{3}.3617278$	$\bar{3}.2304489$	$\bar{3}.1139434$
$\bar{4}.7759970$	$\bar{4}.6945181$	$\bar{4}.5280126$
$\bar{3}.4149733$	$\bar{3}.2787536$	$\bar{3}.1760913$
$\bar{4}.8280425$	$\bar{4}.6928228$	$\bar{4}.5801685$
$\bar{3}.4471580$	$\bar{3}.3424227$	$\bar{3}.2304489$
$\bar{4}.8612272$	$\bar{4}.7564919$	$\bar{4}.6945181$
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$\bar{3}.$	$\bar{4}.8450980$	$\bar{5}.6989700$
$\bar{4}.4149692$	$\bar{4}.2591672$	$\bar{5}.1130392$

$\bar{9}.7781513$
$\bar{9}.1922205$

$\bar{9}.9030900$
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$\bar{9}.0000000$
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$\bar{9}.1139434$
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$\bar{9}.1760913$
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$\bar{9}.2041200$
$\bar{9}.6181892$

$\bar{9}.2304489$
$\bar{9}.6944181$

$\bar{9}.2787536$
$\bar{9}.6928228$

$\frac{\pi D^2}{4} = \pi r^2$

$\frac{D}{2} = r$

$\bar{9}.3222193$
$\bar{9}.7362885$

$\bar{9}.3617278$
$\bar{9}.7757970$

$\bar{9}.3802112$
$\bar{9}.7942804$

$\bar{9}.0000000$
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$\bar{9}.7781513$
$\bar{9}.1922205$

$\bar{9}.8450980$
$\bar{9}.2591672$

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$\bar{9}.0414692$
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$\bar{9}.1139434$
$\bar{9}.5280126$

$\bar{9}.1461280$
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$\bar{9}.2041200$
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$\bar{9}.2304489$
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$\bar{9}.3222193$
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$\bar{9}.6020600$
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$\bar{9}.9542425$
$\bar{9}.3682117$

$\bar{9}.0000000$
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$\bar{9}.0791812$
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$\bar{9}.1461280$
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$\bar{9}.2304489$
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$\bar{9}.2515272$
$\bar{9}.6693417$

$\bar{9}.2787536$
$\bar{9}.6928228$

$\frac{\pi D^2}{4} = \pi r^2$

$\frac{D}{2} = r$

15705
7 8580
17708
15705
7 8 5

1.4142
2 8 2 8
1 4 1 4 2
1 4 1 4 2
1 4 2 3

3.1423
3.1423
1 2 5 6 9
1 2 5 6 9
1 2 5 6 9

113.14159
7 8 5 4

.441
.441
7 8 1
2 7 6
1 4 4
.2 7 2 3 2 1
.7 8 5 4

8 5 0 0 8 9
1 0 6 2 6 0 5
1 7 0 2 1 6 8
1 4 5 7 6 4 2
.7 6 5 9 1 3 9 3 6

144) 5 5 5 , (3,8 5 4 2
4 3 2
1 2 3 0
1 1 5 2
7 8 0
7 2 0
6 0 0
5 7 6
2 4 0

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10020   4.000000000          T.3280610
        0.66403050           T.2231519 1672
        2.00000000
        2.66403050
        D.46131-

10040   4.00173371
        0.66403050
        2.00056665
        2.66459736           T.32979472
        D.46227              T.22448562 1678

10080   4.00346053
        0.66403050
        2.00173027
        2.67376077           T.33152154
        D.46318              T.2286/244 1685

10120   4.00518051
        0.66403050
        2.00259026
        2.66662076           T.33324152
        D.46411              T.22633242 1692

10160   4.00689371
        0.66403050
        2.00344486
        2.67047736           T.33495472
        D.46503              T.22804562 1698

10200   4.00860017
        0.66403050
        2.00430009
        2.66833059           T.33666118
        D.46594              T.23175208 1705

10240   4.01029996
        0.66403050
        2.00514998
        2.67314048           T.33836096
        D.46685              T.23345186 1712

10280   4.01199311
        0.66403050
        2.00599656
        2.67002704           T.34005412
        D.46776              T.23514502 1719
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10320   4.01367970
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        2.00683985
        2.67087035           T.34174070
        D.46867              T.23683160 1725

10360   4.01533976
        0.66403050
        2.00767988
        2.67171038           T.34342076
        D.46958              T.23851 16 1732

10400   4.01703334
        0.66403050
        2.00851667
        2.67255717           T.34509434
        D.47049              T.24018528 1739

10440   4.01870050
        0.66403050
        2.00935025
        2.67338075           T.34676150
        D.47139              T.24185240 1745

10480   4.02036128
        0.66403050
        2.01018064
        2.67421114           T.34842228
        D.47218              T.24351318 1752

10520   4.02201574
        0.66403050
        2.01100987
        2.67503637           T.35007674
        D.47309              T.24516764 1759

10560   4.02366392
        0.66403050
        2.01183196
        2.67586846           T.35172492
        D.47409              T.24681582
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Sq. root 2 = 1.4142, log = 0.1505708

2.66490305
2.5713 5197 3.326
2.4.18 5 8 5 5 7 5 .266
2.4.9 6 3 9 0 0 0 5 .237
2.3.7 4 5 3 5 9 5 .266
2.2.7 7 3 5 3 7 .189

2.66489736
2.5.4 9 3 8 4 5 6 2 .327
2.4.2 6 3 5 3 6 9 3 .267
2.3.1 8 5 6 7 3 6 .237
2.3.1 5 0 0 6 4 .207
2.2.7 5 7 7 9 2 .189

2.66576077
2.5.5 5 2 4 9 9 2 3 .328
2.4.2 7 1 8 7 7 7 .267
2.3.6 7 7 2 7 7 .237
2.3.1 6 2 1 9 5 7 .207
2.2.7 2 2 5 3 3 7 .189

2.66662076
2.5.6 1 0 0 8 8 6 2 .328
2.4.2 5 8 9 7 7 .267
2.3.6 1 5 5 5 6 .237
2.2.1 7 5 9 9 5 .207
2.2.7 7 1 5 3 6 .189

2.66747736
2.5.7 1 6 8 6 6 5 4 7 .328
2.4.2 5 6 7 2 5 3 4 .267
2.3.6 1 4 4 5 3 4 .237
2.3.1 7 5 7 1 4 .207
2.2.7 8 3 9 9 6 .189

2.66833059
2.5.8 7 8 1 9 7 9 .328
2.4.2 9 7 5 7 7 9 .267
2.3.6 1 5 3 0 0 5 .237
2.3.2 5 3 3 3 9 .207
2.2.7 9 2 5 3 7 .189

2.669 18048
2.5.9 1 6 6 8 1 4 2 .328
2.4.3 6 6 0 7 9 4 .267
2.3.6 1 5 5 6 9 5 .237
2.3.2 6 0 1 3 5 .207
2.2.8 0 7 0 3 8 .189

2.67002706
2.5.9 5 1 6 2 6 3 .327
2.4.3 9 4 0 6 .267
2.3.6 4 5 3 5 .237
2.3.2 0 5 3 5 6 .207
2.2.8 0 9 9 3 6 .189

2.67085035
2.5.9 0 3 5 8 3 5 .327
2.4.3 9 2 2 9 7 .267
2.3.6 9 6 4 3 7 .237
2.3.2 1 3 9 8 .207
2.2.8 1 7 9 2 9 .189

2.67170385
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2.4.3 9 3 1 3 3 .267
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2.3.2 2 3 1 9 .207
2.2.8 2 2 3 3 .189

2.67255470
2.5.9 2 3 0 3 6 3 .327
2.4.3 9 3 3 5 .267
2.3.7 0 7 5 .237
2.3.2 3 3 8 5 .207
2.2.8 2 9 3 .189

2.67333501
2.5.9 2 8 6 8 9 5 .327
2.4.3 9 6 0 7 5 .267
2.3.7 0 9 5 .237
2.3.2 3 8 5 5 .207
2.2.8 2 9 3 .189

2.67342118
2.5.9 2 3 7 0 0 3 .327
2.4.3 9 3 6 3 8 .267
2.3.7 0 9 .237
2.3.2 3 9 7 .207
2.2.8 2 5 1 3 3 7 .189

2.67503537
2.5.9 2 4 5 2 7 5 7 .327
2.4.3 9 6 9 5 3 7 .267
2.3.7 0 8 5 3 7 .237
2.3.2 3 5 9 7 .207
2.2.8 2 9 6 0 9 .189

2.67386246
2.5.9 2 5 3 7 3 5 7 6 6 2 .327
2.4.3 7 2 8 9 4 6 .267
2.3.7 1 8 3 2 4 .237
2.3.2 3 7 3 2 6 .207
2.2.8 2 6 7 8 5 .189

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2.0.3 5 3 7 5 9 .109
2.0.1 3 5 1 9 0 .135

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2.1.6 8 9 2 5 .136
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2.0.6 2 5 3 7 .113
2.0.3 7 2 6 5 .109
2.0.1 4 3 8 5 .135

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2.1.6 5 7 5 7 .136
2.1.2 2 7 0 3 .113
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2.0.5 8 1 2 5 .109
2.0.1 5 2 4 9 .135

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2.0.6 1 0 9 .135

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2.0.6 5 .109
2.0.3 9 .135

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2.0.2 .135

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2.0.2 .109

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2.0.2 .135

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2.0.2 .135

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2.0.4 .109
2.0.2 .135

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2.0253 5086 106

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8.000000
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4.000000
7.500000

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6240
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0839	3235	3247,33
0843	3248	3273,25
0846	3260	3299,28
0849	3273	3325,91
0853	3286	3351,65
0856	3299	3377,99
0860	3312	3404,43
0863	3325	3430,98
0866	3338	3457,63
0870	3351	3484,38
0873	3364	3511,23
0876	3376	3538,19
0880	3389	3565,25
0883	3402	3592,41

Page 84

9400	3,97312779 1,98656640 T.65059491 T.30118902 T.19622246	7,94625558 3,74503439 3,97312779 7,78221660 ~~7,85[illegible]~~
9440	3,97497220 1,98749860 T.65151651 T.30303300 T.~~19596886~~	7,99999440 3,75590321 3,97497220 7,78906601
9480	3,97685083 1,98840042 T.65243491 T.30486994 T.~~19990050~~	7,95361166 3,76227847 3,97685083 7,78549649
9520	3,97863685 1,98931850 T.65333491 T.30669980 T.20173336	7,95727738 3,76631219 3,97863685 7,78772250
9560	3,98049579 1,99022290 T.65425895 T.30857190 T.20355946	7,96081158 3,77066039 3,98049579 7,78955960
9600	3,98227212 1,99111356 T.65516611 T.31033322 T.20537678	7,96495424 3,77736305 3,98227212 7,77733593

		Total Weights
9640	3,9840770	7,9685190
	1,9920385	3,7777242, Mag.
	F,6560690	3,9840770 84
	T,3172380	T,7931651
	T,2071736	

9680	3,9858754	7,9717508
	1,9929377	3,7808589
	F,5696982	3,9858754
	T,3139364	T,7949635
	T,2089720	

9720	3,9876663	7,9753326
	1,9938332	3,7849207
	F,6578639	3,9876663
	T,3157279	T,7967554
	T,2107630	

9760	3,9894498	7,9788996
	1,9947249	3,7877877
	F,6587556	3,9894498
	T,3175108	T,7985379
	T,2125464	

9800	3,9912261	7,9824522
	1,9956131	3,7914403
	F,6596436	3,9912261
	T,3192872	T,8003742
	T,2143228	

9840	3,9929951	7,9859902
	1,9964976	3,7950783
	F,6605281	3,9929951
	T,3210562	T,8020832
	T,2160941	

		Total Weights
9880	3,9947569	7,9895138
	1,9973785	3,7986019
	F,6614090	3,9947569
	T,3228180	T,8033450
	T,2177536	

9920	3,9965117	7,9930234
	1,9982559	3,8021115
	F,6622864	3,9965117
	T,3245728	T,8053998
	T,2196084	

9960	3,9982593	7,9965186
	1,9991297	3,8056067
	F,6631602	3,9982593
	T,3263209	T,8073474
	T,2214560	

.40 × x = 1

x = 1/.40 = 40)1.00(1.25
80
200
200

.60 × x = 1

x = 1/.60 = 60)1.00(1.66
60
400
360
40

1 ⅔ ×

2π = 41 2r = R

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13.2.5
.5
6625
3.5
185

Small pulley	25 lb.	2 bearings 3 inches Main shaft
Large "	70 lb.	
Driving "	280 lb.	
2 Idler "	120 lb. together	
Coupling	150 lb.	

Main shaft 23.56 lb per ft. 9 ft. long.

10" Rear pulley 135 lb. 1" diam. shaft.

10" Dynamo armature pulley 1" diam shaft

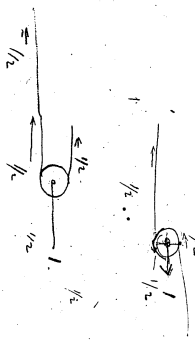
Belt & drive counter shaft - 30 lb.

Bearings 2 1/4".

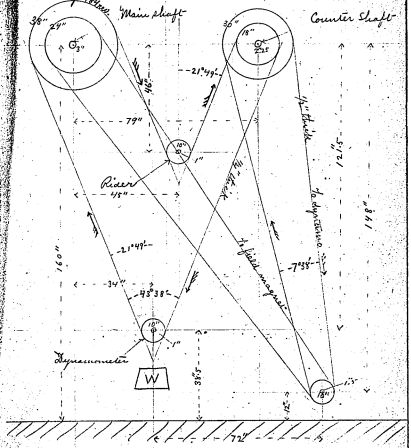
Counter shaft, 4 bearings.

18" pulley	60 lb.
2, 24" "	150 lb. together
30" "	90 lb.
" " "	90 lb.
2, 24" "	150 lb. together

Counter. 13 1/4 lb. per foot, 15 ft. long.



Sketch of shafting and belts from main shaft through dynamometer (Edisons) to dynamo machine. Scale 30 inches to 1 inch.



All dimensions are marked in inches

Fig. 1. April 16th 1880

R. Estimated by Mr. Kruse.

Weight on Main Shaft from dead load. Two bearings 3 inches diam.	Pulley	25 lbs.
	"	70 lbs.
	Main "	200 lbs.
	"	60 lbs.
	"	60 lbs.
	Coupling	150 lbs.
	Shafting 9' long, 23.58 lbs per ft.	212 lbs
Total weight		777 lbs.

This weight is assumed as equally divided between the two bearings

∴ Dead weight on each bearing 389 lbs.

Weight of rider about 135 lbs.

Weight on Counter Shaft from dead load, Four bearings 2½ inches diam.	Pulley	60 lbs.
	"	75 lbs.
	"	75 lbs.
	"	90 lbs.
	"	90 lbs.
	"	75 lbs.
	"	75 lbs.
	Shafting 15 ft. long 13.25 lbs per ft.	199 lbs
Total weight		739 lbs.

This weight is assumed as equally divided between the four bearings

∴ Dead weight on each bearing 185 lbs.

The total weight of belting running from main shaft through dynamometer to counter shaft, and from counter shaft to dynamo is about 50 lbs. The weight on counter shaft due to belting will be weight of belt from counter shaft to dynamo 20 lbs. plus

half the weight of belt from main to counter shaft, a total of 35 lbs. The weight on main shaft due to belting will therefore be 15 lbs. Hence

Total dead weight of main shaft
792 lbs.
" " " on each bearing
396 lbs.

Total dead weight of counter shaft
774 lbs.
" " " on each bearing
193.5 lbs.

Weight of armature of dynamo complete with pulley 170 lbs.

135) 54.5 (.40037 Nat. tan. of angle
540
000
950
925
25
21° 49'

150) 10.00 (.066666
900
1000 Nat. sin. of angle
900
100
3° 49'

Thus the angle of the belt over rider and dynamometer pulley is 43°38' and over dynamo pulley is 7°38'. The other parts are parallel.

76 The speed of pulleys and of power transmission by belts must be made upon the assumption that the diameter of pulleys are increased by the thickness of belt.

Diam. (with belt) of main pulley 38".25

Circumference 120".166

Speed of belting 22110".58

or 1842.55 ft.

This is for main shaft.

The dynamometer and under pulleys have, Diam. 10".25

Circumference 32".2

Rev. per m. 686.6

3.1416
10.25
15.7080
6283.2
3.1416
32.2011600

32.2/22110.58/686.6
193 2 X 11
2770
2576
1745
1932
2138

The diam. of the bearings is 1".77

and Circumference 3".1416

3.1416
686.6
15.7080
188496
25132.8
188496
2157.02256

Surface speed of bearing per m. 2157".

or 179.8 ft.

The main pulley on counter shaft has diameter (with belt) 18".25

Circumference 57".334

3.1416
18.4
25132.8
31416
7854
573332

and, since belt speed is 22110.58 the

No revolutions per m. 385.6

57.334/22110.58/385.6
172002 7
491038
459672
323660
286670
369900

The diam. of bearings is 2".25

Circumference 7".0686

3.1416
2.25
15 7080
6 2832
6 2832
7.0686000

and, since the no rev. per m. is 385.6 the surface speed of bearings will be 273"

7.0686
385.6
42 4116
35 3430
56 5488
21 2058
2731.6521.6

or 227.7 ft.

The dynamo pulley on counter shaft has diam. (with belt) 30".5

3.1416
30.5

Circumference, 95".8888

and, since no. of rev. per m. is 385.6 the surface speed and speed of belt to dynamo will be 36948"

95.8888
385.6
5749.1328
4790.9440
7665.8304
2874.5664
36947.2928

or 3079 ft.

The pulley on armature has diam. (with belt) 10".5

3.1416
10.5
15 7080
31 4160
32.9868 0

Circumference 32".99

Therefore the no. of revolutions per minute is 1120.

32.99/36945.00/1120
32.99 x 1
39 58
32 99
65 90
65 90

The diam. of bearing is 1".5

Circumference 4".7124

3.1416
1.5
15 7080
31 4160
4.7124
1120
94 2480
47 1240
47 1240
5277.8880

Therefore surface speed of bearing is 5277.9"

or 439.8 ft.

1st case.

Assume that we start from the dynamo pulley with 10 H.P. or 330000 ft-lbs. per minute.

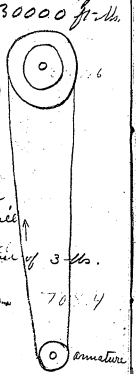
Coefficient of friction is taken as .05 (See page 83)

The weight of armature and pulley complete is 170 lbs. Since belt speed is 3079 ft. the strain will be about 108 lbs. which will leave 62 lbs pressure on armature or friction resistance of 3 lbs. at 439.8 ft. per m.

The power consumed is therefore 1317.4 ft. lbs.

439.8
3
1317.4

which added to the 10 H.P. consumed in induction &c gives 33131.7 ft. lbs.



This weight of 108 lbs. may be considered as increased on dynamometer belt in ratio of 305 to 18 or 180 and adding 3 lbs. for extra to transfer friction power to counter shaft we have 108 + 186 = 294 lbs the pressure due to strain on belts

The weight of counter shaft with pulleys &c is 774 lbs. (See page 74) and the resistance due to friction (774+294)0.05 = 53.25 lbs. which resistance is overcome at the speed of 227.7 ft. per minute.

The power consumed is therefore 12125 ft. lbs.

227.7
38.7
7593.99
18216
6831
8811.99

making total power consumed to this point 343442 ft. lbs.

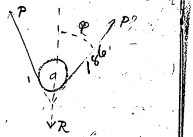
Transferring this to the dynamometer belt which has a speed of 1843 ft. per min. the strain upon the power side

of that belt will be 186 lbs.

We will assume in obtaining the weight lifted at the dynamometer pulley that no power is consumed in friction then

$R = 2P\cos.\varphi$.

$R = 2P\cos.21°49'$.



$R = 345$ lbs. which will be the weight lifted when 342550 ft. lbs. per m. pass the dynamometer.

The resistance due to friction will be 17.25, which resistance is overcome at the speed of

179.8 ft. per minute, consuming 3102 ft. lbs. a total of 346544 ft. lbs. or 16544 ft. lbs. due to friction, or $\frac{1}{2}$ H.P.

When the arm of the rudder is properly balanced the small amount of friction due to it may be neglected as practically there is no pressure on the bearings. The weight on dynamometer 345 lbs. equally divided between main and counter shafts will increase friction to

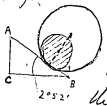
$3515 + 16544 =$

20059 ft. lbs.

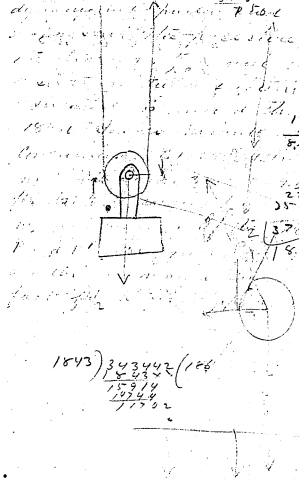
No allowance is made for stiffness of belts as they have been used some time and are pliable.

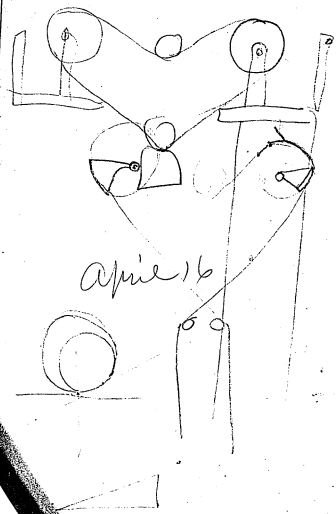
Assume the coefficient of friction to be according to good authorities, for bearings well lubricated, to be .05, the angle of friction is 2°52'.

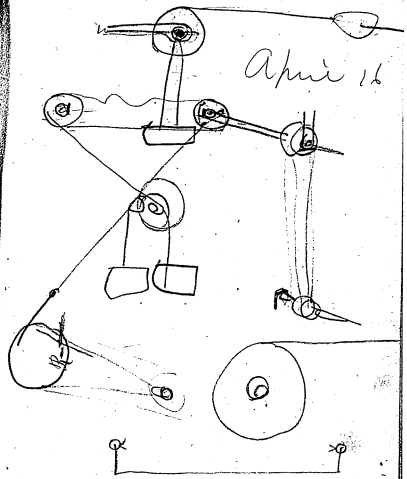
Fig. 3

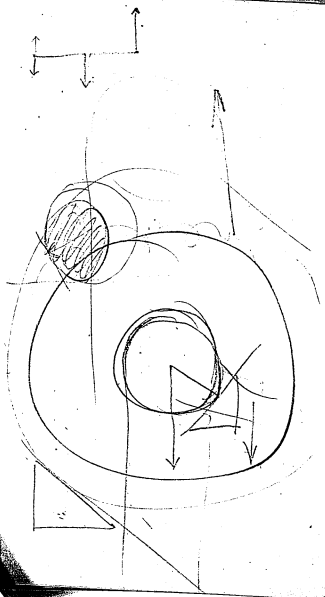


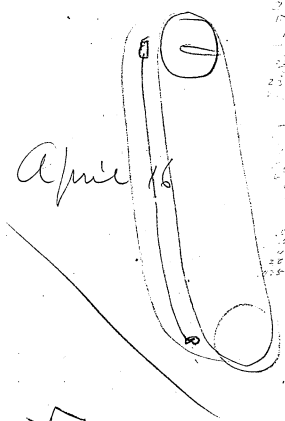
The pressure on the bearing surface due to the shaft running up the side of the loose bearing will be in the ratio to the downward pressure of BC to AB or 1 to 1.001 and can be neglected without appreciable error, being less than ½% in calculation of friction. The loss will be about balanced by the gain in neglecting stiffness of belts.




April 16


April 16



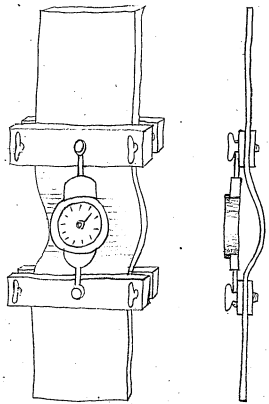


April 16

173
10.7
1.0.3
.094
10.3
.0484

April 17, 1880

Clark



American Machinist
Report on efficiency of
Edison dynamo.

It is stated that the first experiment is "to show the power consumed by the generator, the armature being 9 1/4 inches diameter and 9 inches face

1092 − .7(t − .32)

t − 32° = t − 212° + 180°

1092
260
766

299.113

331.113
32
299.113
305
1495515
899339
94229465

606.5
9
5)5455
1091.7

2.5
1.224
207.884

1091.7
32
299.113
305
1495515
899339
94229465
1091.7
32
1214.929465

75
32
43
305
215
129
13115

1091.7
1104.815
32
7136.815

1214.929465
207.884
1007.045
32
975.2045

1091.7
207.884
883.816

11).300(.027
22
80
77
.04) 0

15.60
14.01
1.59

15.6)1.590(1
1560(

5 .3

15.68)14.010(.95
~~940~~
1404
700

19.9).1.350(.068
1194
1260

)7.58)6.64(8
604
680

41.39).3100(7
5573

5.58)4.08(.730
4068
640

15.68).3.30(.9
1.5

10

5.58)4.08(7
4.06

7.58) 6.64(8
600
680

1151)2600(2.3
2302
3980

1210.823
1210.576
.247
.326
1482
494
741
.080522

1151)17411)1225
1137
2600
2300
2880
2303
1576

63
304
.326

111.113
110.110
1.003
59
9027
5055
.591177

1210.576
.081
1210.657
110.7
1089.957 units

110.11
110.7

per lb. of water at 71.63 pressure from temp. 110.590

161573.28
1089.96
96943968
14541595 2
14541595 2
161573 28
177665 97.86 88 units the total consumed.

70.
69.324
.676

1210.326
1210.074
.252
.696
1512
2268
1512
.175392

1210.074
.175
1210.249
150.542
1029.707 no. units per lb. of water from 180° to 70 lb. pressure.

1029.707)177665 97.86 88(172540
1029707 XXXX
7469527
7207949
2615788
2059414
5563746
5148535
4152118

1615 73
1100
1615 7300
5157 3
1029.7) 1777 3029 6.0 (1726 03
1029 7 7 7 7
74 760
72079
2681 3
2 6 5 9 4
6 2 1 9 0
6 1 7 5 2
4 0 5 0 0
3 8 5 9 7
7 7 0 3 0

.1305
1100
14300
5 5 7 9 00
1 0 9 1 7
32.
1178.6

$\log (v^{r-1})^{r-1}$

$\frac{dv^{r-1}}{v^{r-1}}$

$r-1 \log \frac{1}{v}$

$r-1 \cdot \frac{dv^{-1}}{v^{-1}}$

~~dv~~

$r-1 \log v^{-1}$

$r-1 \frac{dv^{-1}}{v^{-1}}$

$-v^{-1} dv$

$\log v^{-(r-1)}$

$\log v$

v^{r}

$v^{r} dv$

331.113
32.
299.113
.695
1 4 9 5 5 6 5
2 6 9 2 0 1 7
1 7 8 4 6 7 8
2 0 7.8 8 3 5 3 5

.695
180
5 5 6 0 0
6 9 5
1 2 5 1 0 0

1 0 9 1.7
1 2 5 1.1
9 6 6.6

$\log \left(\frac{1}{v}\right)^{r-1} - \log \left(\frac{1}{v_0}\right)^{r-1} = \log r - \log r^0$

$\log \frac{\left(\frac{1}{v}\right)^{r-1}}{\left(\frac{1}{v_0}\right)^{r-1}} = \log \left(\frac{r}{r^0}\right)$

$\log \left(\frac{\frac{1}{v}}{\frac{1}{v_0}}\right)^{r-1} = \log \left(\frac{r}{r_0}\right)$

$\frac{r}{r_0} \left(\frac{v}{v_0}\right) = \frac{p}{p_0} \left(\frac{v_0}{v}\right)^{r}$

$\frac{p_0 v_0}{r-1} - \frac{p_0 v_0^{r}}{v^{r-1} v}$

~~$p_0 v_0 v^{r-1} - p_0 v_0^{r} v$~~

$\frac{1}{r-1} \left(p_0 v_0 - \frac{p_0 v_0^{r}}{v}\right)$

$\frac{p_0 v_0 \left(\frac{v_0}{v}\right)^{r-1} v^{1-r}}{1-r}$

$2 \times dx$

$2 x^{2-1}$

$\frac{v^{1-r} dv}{1-r}$

$$\cancel{+\frac{p_0 v_0}{\gamma-1}\left(1-\left(\frac{p}{p_0}\right)^{\frac{\gamma-1}{\gamma}}\right)}$$

$$\cancel{-\frac{p_0 v_0}{\gamma-1}\left(1-\left(\frac{p_0}{p}\right)^{\frac{\gamma-1}{\gamma}}\right)}$$

$$\cancel{-\frac{p_0 v_0}{\gamma-1}}$$

$$v = \left(\frac{c}{p}\right)^{\frac{1}{\gamma}}$$

$$v = \frac{c}{p}$$

$$\left(\frac{c}{p}\right)^{\frac{1}{\gamma}} = \frac{c}{p}$$

$$\frac{p_0 v_0}{\gamma-1}\left\{1-\frac{v_0^{\gamma-1}}{v^{\gamma-1}}\right\}$$

$$\frac{p_0 v_0}{\gamma-1} - \frac{p_0 v_0^{\gamma}}{v^{\gamma}(\gamma-1)}$$

$$\frac{p_0 v_0 v - p_0 v_0^{\gamma}}{v^{\gamma}(\gamma-1)}$$

$$p_0 v_0\left(\frac{v - v_0^{\gamma-1}}{v^{\gamma}(\gamma-1)}\right)$$

between limits v_0 and v

$$p_0 (v_0)^{\gamma}\left[\frac{v^{1-\gamma}}{1-\gamma} - \frac{v_0^{1-\gamma}}{1-\gamma}\right]$$

$$p_0 (v_0)^{\gamma}\left[\frac{v^{1-\gamma} - v_0^{1-\gamma}}{1-\gamma}\right]$$

$$p_0 v_0^{\gamma}\left[\frac{v_0^{1-\gamma} - v^{1-\gamma}}{\gamma-1}\right]$$

$$\frac{p_0 v_0}{\gamma-1}\left[v_0^{0} - v^{1-\gamma} v_0^{\gamma-1}\right]$$

$$\frac{p_0 v_0}{\gamma-1}\left[1 - \frac{v_0^{\gamma-1}}{v^{\gamma-1}}\right]$$

$$\frac{p_0 v_0}{\cancel{\gamma-1}} \times \frac{\cancel{\gamma-1}}{p v}\left(\frac{1-\left(\frac{p_0}{p}\right)^{\frac{\gamma-1}{\gamma}}}{1-\left(\frac{p_0}{p}\right)^{\frac{\gamma-1}{\gamma}}}\right)$$

$$\frac{p_0 v_0}{p v}\left(\frac{(p_0)^{\frac{\gamma-1}{\gamma}} - (p)^{\frac{\gamma-1}{\gamma}}}{(p_0)^{\frac{\gamma-1}{\gamma}}}\right)\left(\frac{(p)^{\frac{\gamma-1}{\gamma}}}{(p)^{\frac{\gamma-1}{\gamma}} - (p_0)^{\frac{\gamma-1}{\gamma}}}\right)$$

$$\frac{(p)^{\frac{\gamma-1}{\gamma}} p_0 v_0}{(p_0)^{\frac{\gamma-1}{\gamma}} p v}\left(\frac{(p_0)^{\frac{\gamma-1}{\gamma}} - (p)^{\frac{\gamma-1}{\gamma}}}{(p)^{\frac{\gamma-1}{\gamma}} - (p_0)^{\frac{\gamma-1}{\gamma}}}\right)$$

Now $\frac{p_0 v_0}{p v} = \left(\frac{p_0}{p}\right)^{\frac{\gamma-1}{\gamma}}$

$$\left(\frac{p}{p_0}\right)^{\frac{\gamma-1}{\gamma}} \times \left(\frac{p_0}{p}\right)^{\frac{\gamma-1}{\gamma}}$$

$$\frac{p_0 v_0}{\gamma-1} \times \frac{\gamma-1}{p v}\left(\frac{(p_0)^{\frac{\gamma-1}{\gamma}} - (p)^{\frac{\gamma-1}{\gamma}}}{(p_0)^{\frac{\gamma-1}{\gamma}}}\right)\left(\frac{(p)^{\frac{\gamma-1}{\gamma}}}{(p)^{\frac{\gamma-1}{\gamma}} - (p_0)^{\frac{\gamma-1}{\gamma}}}\right)$$

$\frac{1}{\gamma-1}(p_0 v_0 - p v)$ expended

$$\cancel{\frac{1}{\gamma-1}}$$

$$\begin{array}{r} 169 \\ 238 \\ \hline 407 \end{array} \qquad 407) \overline{32000}(\ldots$$

$$\begin{array}{r} 32000 \\ 32000 \\ \hline 3120 \end{array}$$

$$\frac{\left(\frac{p}{p_0}\right)^{\frac{\gamma-1}{\gamma}} - 1}{1 - \left(\frac{p_0}{p}\right)^{\frac{\gamma-1}{\gamma}}}$$

$$\frac{(p)^{\frac{\gamma-1}{\gamma}} - (p_0)^{\frac{\gamma-1}{\gamma}}}{(p_0)^{\frac{\gamma-1}{\gamma}}} \times \frac{(p)^{\frac{\gamma-1}{\gamma}}}{(p)^{\frac{\gamma-1}{\gamma}} - (p_0)^{\frac{\gamma-1}{\gamma}}}$$

$\left(\frac{p}{p_0}\right)^{\frac{\gamma-1}{\gamma}}$ 1000000)10.64 000 000 (0001064

10 000 000
6 400 000
6 000 000
4 000 000 00
4 000 000 00

4/2.1416
.7854

.7854).00001064000(135
.7854
2 7860
2 3562
4 2980
3 80

.00001064
.7854
4 2560
5 320
8 512
7448
.0000835664
.0000 1783 280

.000042

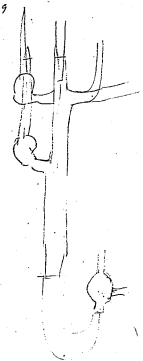
.000042) 396 000 (9412
378 ×
18 0
16 8
1 200

$p = Ar$ $A = \frac{p}{r}$
$dp = A\,dr$
$dy = p\frac{dr}{r}$

$r^{-1}dr = v^{-1}dv$
$\frac{dr}{r} = \frac{dv}{v}$
$\log r = \log v$
$r = v$

33000
420
660000
330000
44.3) 3 960 000 (8939
3 54 4 ×
4 160
3 987
1 730
1 329
4 010
9443 000 000
0009

772) 396 0000 (1129
3 560 ×
1 000
7 920
2 880
7 560
3 60



3.46
55
2076
2076
228.36

14.26
46.1
85 56
85 56
941.16
941.16
5646.96
941.16
941.16
37646.4
897044
85 5782.1 / 4 5-6 / 941.2
81
184 / 757
736
1841 / 2582
1841 / 2581
1842 / 301 14
85 5782.2896
5-2148.2896
8336 33.710 / 913.3
37
228.36
228.36
137016
68508
182688
45572
52148.2896

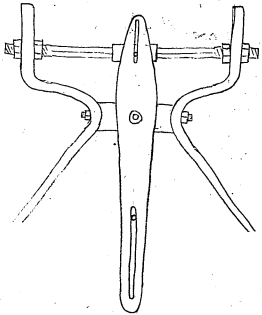
181 / 236
181
1823 / 5533
5-5
1824 / 5577
1824
194.18
913.3.
3425 4
3425 4
1918
10276 2
435-60. / 1042 80.5994 / 2.39
871 20 / 18
1716 05
1306 80
409 259
392 040
27 33
20 39
1.34

This said to have 2 Daniells cells connected to the magnet acting.

Correction = so that there was an Electromotive force of two Daniell Cells on the field magnet, which consumed about 250 feet lbs; this was nothing but a preliminary test and you were requested to throw this out, which was accomplished.

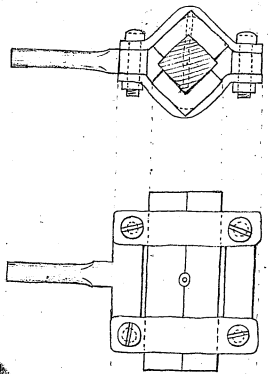
You say that with machine on a ~~[illegible]~~ fast and with chop shaft + Commutator

Indicator motion. May 31, 1880



Running that the Card A gave 9.59 h.p. when the Belt was thrown off of the Dynamo machine the Indicator Card B gave 4.15 horse power showing that the friction of the various trains & machinery consumed was 5.42 h.p. Now as over a dozen of my young men at the Laboratory have turned the dynamo by a hand

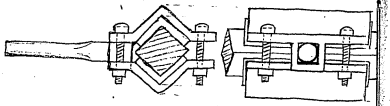
May 31, 1880.



power machine through an intermediate belt at the rate of 1000, per minute, it is apparent that there is an enormous discrepancy between ~~[illegible]~~ your 5.42 hp and the power of one man =

after field was taken off the difference by your indicator and between the machine running free & when the ~~work~~ field was on was 1.51. hp

(which is stated as E.M.F. Force equal to 2 Daniell's cells)



Either use the arm, page 100, or a bar as shown below, the guide pins a, b, c, d, being on a spindle e which is free to turn.

as a man can turn on the hand power nearly the same speed with the field off as on the 1.51 h.p. shows an enormous discrepency. In your article you say "difference between the machine running free & connected", you do not say "how connected", whether the field magnet, or the induction bobbin; Even to an expert this without any explanation was

be totally blind -

You say a coil of wire
said to be 174 Ohms.
The resistance of the
coil was one ~~[illegible]~~
four hundredth of
an ohm,

You say that the tank
should be of wood
to prevent conduction
of heat through the
sides ~~of the tank~~
The very essence of all

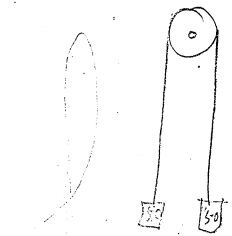
Calorimeter is that the
tank should be of metal
preferably a metal which
conducts heat the best.
& Copper is always
Employed, to the end that
the temperature of the
tank should be the
same as the water
otherwise no calculations
of the heat of the tank
can be obtained,
the radiation of the

low temperature is an
Extremely small fraction
of the total heat. it is
so small that in nearly
all Experiments it is
neglected. ~~at high~~
~~temp~~ & it may be
Entirely neglected
if the temperature of the
water is started as
much below the
atmosphere as it is
brought above it by
the storage of Energy
in the coals

You say, in first calorimeter test,
173 lbs of water.
·23 iron
·65 of wood,
·05 - Copper
whereas as the wood was
·65. you have multiplied
it not correctly =

---

1. You assumed that the
pressure ~~on~~ at the Cylinder
was the same as the boiler,
neither did you take
into consideration or correct
the pressure gauges, sometimes
there are 13 lbs diff between
the two gauges, &



You have in first experiment the specific heat of copper as .049 whereas it should be .094 (a typo. error as the result in Units of Heat column is correct).

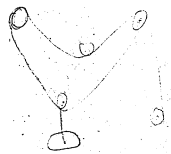
You refer the units of heat developed in the calorimeter, back to the cylinder and base your calculations upon a boiler pressure ~~given by gauge obviously incorrect~~. And even ~~were they correct there would be diminution of pressure~~ due to friction in pipes & bends, steam ports, and very little from loss of heat all of which should be passed by and the indicator springs if at all correct be considered as giving the true pressure.

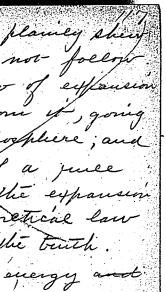
1841.487
772
3682974
12890409
12894409
1421627.564

33000)236938(7.1
231
5938

33000)272355(8.2
264
8355

1841.487
3683
1421627.564
9207435
3683974
12891409
1841487
5524461
33000)236938(7.2
231
5938
516177
4614777
3233
11793
198)2369.38(8.7
1584
7.27





~~Your indicator cards plainly show that the steam does not follow the theoretical law of expansion but is very far from it, going way below the atmosphere; and the application of a juice which supposes the expansion to follow the theoretical law will be far from the truth.~~

~~Besides, heat is energy and there is the energy~~ (directly shown in the heating of the water, namely 1,841.487 × 772 or 1421628 ft. lb. for every minute or 236938 ft. lb. per minute = 7.2 H.P. There is no reason for going behind this fact. By using a formula involving the thermo-dynamic equivalent of heat and finding the horse

continued

628.2) 1195.4108 (1.8
628.2
567.21
1195.4108
.01602

.01602) 1195.4108 (74619.9
1121.4777
7401
6408
9930
8652
3188
1602
15860
14418
14420

628.2) 16170 (25.66
1256.4
3560
3140
4160
3768
3920
3768
1520

628.2) 74619.9 (118.8
62820
11799
6282
55179
50256
4923.0

628) 20620 (3
1884
2260
1884
376

16.5
2.6
990
330
42.90

1195.4108
.0888
9788664332
10758669972
10758669972
1158238

42) 33.88 (0.8
33.6
10.88
8.4
2.48

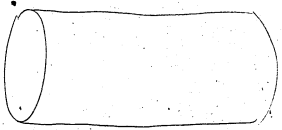
42) 1072.9 (25.54
84
23.9
21.0
2.6
2.1
0.5
0.4
0.1
0.1
0.0
1032.0

32.69
.3

1195.4108
1174.912
16.4985
2.8

1072.6
.09
96.534

1072
.09
9648
9648
106.128



.1841
.1779
.642
.772
.1329
.4634
.4634

1195.4
1145
50.4
77.2
4008.5
3585
3585
3585.0
3585
3585
3059
2390
669.0

198) 51106.4 (1195) 32.5

1000) .4640 (.000464
4000

.000464
304
18556
1392
.141056

1195.4108
.141056
1195.269744

1000) 110.0 (.11
304
11
304
304
33.44

1612
33.44
1645.44

~~1625.2~~

1000) 15.40 (.01540
1000
01540
304
616
462
4.6816

625.2
4.6816
632.8816

1000) 1.057 (.001057
1000

.001057
304
4225
317
.321328

1178.912
.321328
1178.590672

1195.269744
1178.590672
16.679072
16.6790 04
16.68

.31635 2
587269
287269
167544
174459 3 9 20 (27.566
1178 9 0 6 7 2
478833
443016
358179
164440
41733 92
37 7 7 2 4
3766 40

$$\left[\log_e\left(\frac{L}{l}\right)+1\right]\left(\frac{pl}{L}\right) = \text{Mean}$$

$$\left[\log_e\left(\frac{L}{l}\right)+1\right]\left(\frac{pl}{L}\right) \times \text{Stroke}$$

1195.27 : 1

1195.27) 1841.487 (1.54
1195.27
646.217
597635
485820

power corresponding to the amount of heat developed in calorimeter you have employed ~~if~~ that heat to raise water to steam at 25 lbs. boiler pressure and then used it in a steam engine, where we well know but a small part of the heat can be, even theoretically, returned in work. It never was proposed to convert the calorimeter into a boiler, in which steam is generated by a copper wire heated by electricity, as the same electricity would give vastly greater economy in an electro-dynamic machine. The idea

122

632.55) 16 45.44 (2.6
1265 76
379 680
379 728

Hyl. log. of 2.6 = .956 + 1 = 1.956

25
14.496
2.6) 39.4896 (15264
36 XX
26
130
69
53
176
156
200
197
3

1195.27) 16.678900 (.0139
11 95270
4726630
3585810
11404990
10751
7

15.264
1.956
91584
76320
137376
152640
29.85638 4

.139
.26
834
278
.03614

1195.27) 1178.59 (.98
10 75743
10284704

772) 31,1450 (.0403
30 88 4
2650

772
1 32
6732
2316
27832

Expended 16.95 11.53
recovered 7 +
Expended 18.65 13.28
recovered 6.8

5.35
2.56
8.22

33.52
7.5
16760
23464
23464
2597.800

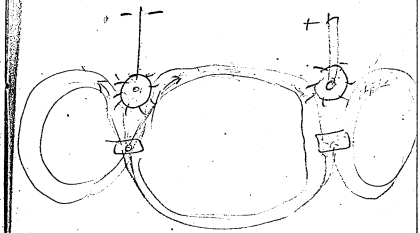
11.15
33 000
345
345
3795 000

3795 00) 25 97 800 (6.8 H.P
60
22770
32080
29160

22.8
4.15
18.65

purpose is to heat the carbon 20
top of the electric lamp.

The horse power in the 184,487 units of heat ~~that~~ have shown to be equal to 7.2 H.P.



and yet your formula shows only .63 H.P. The natural ~~inference~~ inference to be drawn from your calculations in this instance would be that .63 H.P. internal work has mysteriously produced 7.2 H.P. external

work! The same discrepancy is seen in second experiment where $\left(\frac{335197}{11.5}\right)\left(\frac{772}{33000}\right) = 6.8$ H.P. external work is produced by .599 H.P.! You have made a slight mistake in arithmetic making it .81 instead of .599.

Since in the first experiment the balance of work, as shown by indicator, which H.P. was expended in heating the wire in calorimeter was 11.53 H.P. and the amount of heat returned in calorimeter were equivalent to 7.2 H.P. the efficiency by your own data should be $\frac{7.2}{11.53} = 62\%$ and in second experiment $\frac{6.8}{13.28} = 51\%$. at the least

1072.6
115.59
965.34
75830
53630
10226
10226
123981.834

3351.97
51.192
6703.94
13407.88
33519.7
335197
1055591

10738.049.74
2178
93948.3
7307.09
10335.7
208774

375500)22245.9.22 3(5.99
1875000
3770.9.27
3775.09
35542.73

1072.6
76.7
7508.2
6435.6
10726
179 12.42

2985.4
77.2
5970.8
2097.8
2097.8
100)230472.9

13.28(6.800(.51
6640
1600
1330
2720

1072.6
1.0282
7508.2
8558.08
965.34
1058.56
16.7
7410592
6351936
1058.56
7767.95552

6)1768
294.6⅔
77.2
5892
2062.2
2062.2
2062.4
2.2 2 6 2.6(.69
7.08
2.99
2.7
982

1768
77.2
3536
12376
12376
13689.6

1195.27
1178.60
16.67

~~Know that in order to make them all efficient as work the steam would have to come down in temperature to zero and be doing work at the time which is impossible. even in expanding in a compound engine to one pound above vacuum which is an extreme case the pound of steam containing 1195 units would part with only 50 units and the remaining 1145 must be lost. But with our non-condensing engine the steam can do work only down to atmospheric pressure at the utmost, giving up nearly 16.7 units in work~~

1195
1178
17

11000000
30
33,000,000

267
213.

6282
1612.

33000
60
1,980,000

267
213
44

0711

2011

213
490
703

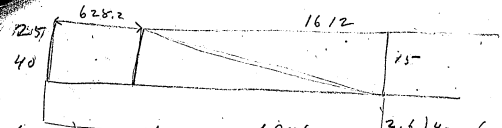
1
16

44
703) 440 (16
44) 703
44
263
264

In view of this fact then every 1195 units would give only 16.7 units in work and since by your data 1072.6 cu. ft. passed through in 6 minutes, containing 1195 units per lb. and giving up as work 16.7 units per lb., the number of units in work would be 1768 units in 6 mn. or 13648.96 ft. lbs. per mn. or 227.4883 ft. lbs. per sec. = 6.9 H.P. whereas the Calorimeter returned 7.2 H.P. showing undoubtedly that the gauges were inaccurate.

(1072.6)(0.0827) = 105.5656 lbs.

0.0827
1195
0.0827
0.0827
0.0827

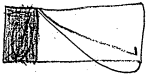


628.2) 1612.0 (2.6
25.6
35.56.0

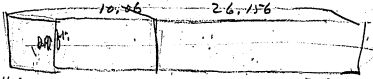
1.956
.25
9780
1956
29.340
1.5
14.34
2.6
8.0
2.8
3R.284

2.6) 40.0 (1.5
26
140
130

16



.0994) 1.0000 (10.06
994
10.06
×2.6
6036
2012
26.156

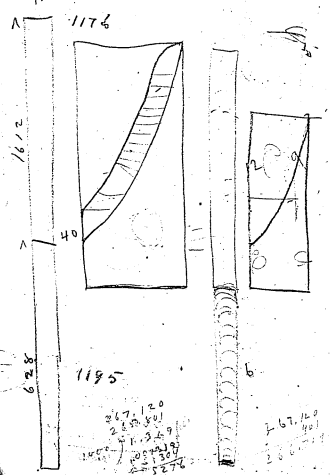


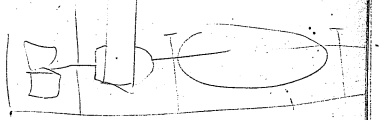
14.34
144
5736
5736
1434
206.496
26.1
123897
10324
10324
206496
123897
1129.92
5401.1
10.5856
3200
2700
4320
2700
5401
5721.79

775
16.7
5425
4650
775
129.4 2.5
2.6
7755
5850

775
25
3875
1550
1937.5
785
5812.5
123937.5
6799.10
67879
67879
96.0860 50

775
33
3875
5812.5
9529.84 (29.
66
292





1195.27 — at 25 lbs. t.p.
1178.59 — at atmosphere.
16.68

Temp. 266°.719
212°
54.719

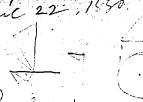
54.719
726.719

726.719 / 13 = 55.94

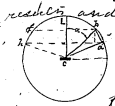
13 / 1195.27 (91.94
117
52
13
39
132
117
157
156
91

91.94
72
183.88
82.58
82.58
1977.88
1055.7
4964.96
5658.24
3548.0
70978
6 / 75144440.86
33000 / 1252407 (37
99 x
262
237
374

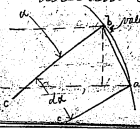
April 22, 1890. Clarke



Prof. Rowland's demonstration of power of electric light as worked out from the final results and diagram as given by him in a letter to me.



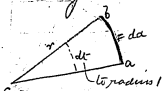
If c is the plane surface from which the light emanates and L is the power in the direction of the normal to that surface (supposing the plane c to be within a sphere so large that all points are practically at the same distance from the surface of the sphere) then the power in the direction cb would be $L \cos \alpha$.



value of light $= L \cos \alpha$.

We suppose the radius of the sphere equal to unity.

The circumference of the circle on the parallel bf is $2\pi \sin \alpha$ and if this be multiplied by arc ba corresponding to angle $d\alpha$ it will give the area of the zone.



The differential equation then gives $d\alpha = (r\,d\alpha^2 + dr^2)^{1/2}$, but $r = 1$, $d\alpha^2$ should therefore be $d\alpha^2$ and equal to $d\alpha^2$, this being a circle r is constant and therefore equal to zero, hence $d\alpha = (d\alpha^2)^{1/2}$, and $d\alpha$ is length of arc.

The area of zone is then $2\pi L \sin \alpha \cos \alpha \, d\alpha$ and for the equal zone on opposite hemisphere also we have total $4\pi L \sin \alpha \cos \alpha \, d\alpha$ which is to be integrated between

limits $\frac{\pi}{2}$ and 0 π.

Total value $= 4\pi L \int_{\frac{\pi}{2}}^{0} \sin\alpha \cos\alpha \, d\alpha$.

$\cos\alpha \, d\alpha = d.\sin\alpha$

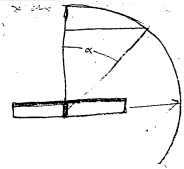
$\therefore$ Value $= 4\pi L \int_{\frac{\pi}{2}}^{0} \sin\alpha \, d.\sin\alpha$.

Integral of $\sin\alpha \, d.\sin\alpha =$

$\frac{\sin^2\alpha}{2}$ which for $\frac{\pi}{2}$ is equal to $\frac{1}{2}$, hence

Value $= 2\pi L$.

The surface of a sphere is its radius unity, equal to 4π and if light had been of same value in all directions its value would be $4\pi L$. The actual value of face is therefore one half the value perpendicular to the face, the greatest value.



The full value of the edge as shown by arrow is l and the value will be proportional to the cosine of the complement of α or to the sin of α and the formula for face value will give the value for edge

value $= 4\pi l \int_{\frac{\pi}{2}}^{0} \sin^2\alpha \, d\alpha$.

Integral of $\sin^2\alpha \, d\alpha =$

$\frac{\alpha}{2} - \frac{\sin 2\alpha}{4}$, and for the limit 0 their values will be 0 but for limit when $\alpha = \frac{\pi}{2}$ we have

$\frac{\pi}{4} - 0 = \frac{\pi}{4}$. hence

value $= 4\pi l \left(\frac{\pi}{4}\right) = \pi^2 l$,

but if the value of $\underline{l}$ had been equal in all directions it would have been, as with face, equal to $4\pi \underline{l}$ hence the actual value is $\frac{\pi}{4}$ or .7854 of the edge value. Hence having found by photometer the face and edge values we have average value in every direction equal to

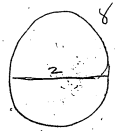
$$\frac{L}{2} + .7854\, l.$$

This supposes the value of $\underline{l}$ to be constant which would be the case with Edison's carbon loop only when a perfect circle and no separation at the bottom which of

3.14159

course is impossible.

3/0000000000

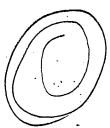


12960
2.73
38880
90720
51840
61300

$\frac{4}{1}$

$\frac{1}{1}$

775) 61300 (7
54250
7050



772) 61300 (79.4
54000
7260
6948
3120

50 to 1. 772) 3600 (7.2
5400
1900
1160.

0000

0000

0000000

965.7) 72.150 (.0747
67599
45510
35625
68820

78.98) 888.34 (
888.34) 78.9800 (.089
71 0.672
791280

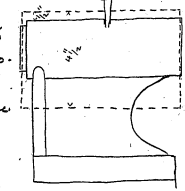
773) 55.700 (72.15
5404 ×
1560
1544
1552
3880

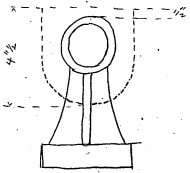
772) 61.350 (79.41
54 0 7 ×
7260
6948
3120
3088
320

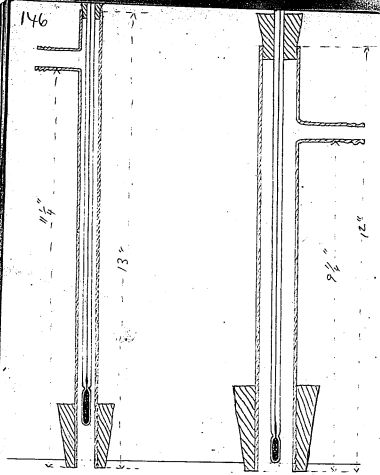
Calorimeter for pieces of block

May 1, 1880

on commutator side of Edison's dynamo-electric machine

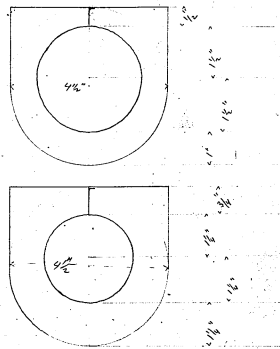






+ width of pillow block +

+ width of bushing +



May 3rd 1880.

Calorimeter Test of energy lost by friction in bearing on the commutator side of Edison's dynamo-electric machine.

The thermometers will be designated as follows.

A, the long thermometer graduated to half degrees.

B, the short thermometer graduated to even degrees.

Temperature of air at beginning of experiment by A was 75 3/4 °F.

The reading of A is greater than B by 1/4 °F. A will be taken as the standard.

1st Test for obtaining the rate of cooling or loss in the calorimeter. Dynamo not running and at temp. of air.

Time	Weight	Temp. of inflow. Thermom. B	Temp. of outflow Thermom. A.
h m s	lb oz		
2-42-30	8 - 9	98-5 °F	93- °F
2-43-30	8 - 15	98-5	95
2-44-30	9 - 6½	98-	94-75
2-45-30	9 - 14	98-	94-75
2-46-30	10 - 5½	97-75	94-6
2-47-30	10 - 13	97-5	95-75
2-48-30	11 - 4½	97-	94-5
2-49-30	11 - 11½	97-	94-3
2-50-30	12 - 3	96-8	94-2
2-51-30	12 - 10	96-5	94-1
2-52-30	13 - 1	96-3	93-9
2-53-30	13 - 7½	96-	93-9
2-54-30	13 - 15	95-8	93-5
2-55-30	14 - 6	95-6	93-3
2-56-30	14 - 12	95-	93-2

Temp. of air at end of experiment. 76 3/4 °F. by A

4 oz
1 "
2 " Marly
1 " Brace
½ " Solder

8½ oz

Dynamo not running and at Temp. of air.

Temp. of air at beginning of experiment. 77°.3 F.

by A.

2nd test for obtaining the rate of cooling or loss in the calorimeter

Time	Weight	Temp. of Inflow. Thermom. B.	Temp. of outflow Thermom. A.
~~h. m. s~~	~~lbs. oz~~		
3-28-30	5 - 8½	120-5 °F	106-5 °F
3-29-30	6 - ½	120-5	109
3-30-30	6 - 8	120-	109
3-31-30	6 - 15½	120-	110
3-32-30	7 - 6½	119-5	110-25
3-33-30	7 - 14	119-	110-50
3-34-30	8 - 5½	118-5	110-75
3-35-30	8 - 12½	118-	110-75
3-36-30	9 - 3½	117-75	110-75
3-37-30	9 - 10½	117-	110-75
3-38-30	10 - 1½	116-75	110-75
3-39-30	11 - 6½	116-25	110-75
3-40-30	12 - ½	115-50	110-75
3-41-30	12 - 8	115-	110-50
3-42-30	13 - 1	114-75	110
3-43-30	13 - 8	114-	109-75

Temp at end. 76°.5 by A.

Dynamo not running and at temp. of air.

Temp. at beginning of experiment. 76°.5 F. by A.

3rd Test –
Cold Water used instead of hot.

Time P.M. h. m. s.	Weight	Temp. of Inflow Therm B. °F	Temp. of outflow Therm A. °F
	0½ – 0		
4-6-30	5 – 13	56 – 75	73 – 5
4-7-30	6	57 –	73
4-8-30	6 – 4½	57	72 – 5
4-9-30	6 – 6	57	72
4-10-30	6 – 8½	57	71 – 5
4-11-30	6 – 11	57	71
4-12-30	6 – 14	57	70 – 5
4-13-30	7 – ½	57 – 5	70 – 25
4-14-30	7 – 3½	57 – 5	70 –
4-15-30	7 – 6	58 –	69 – 5
4-16-30	7 – 8½	58	69 – 5
4-17-30	7 – 11	58	69
4-18-30	7 – 13	58	69
4-19-30	8 –	58	68 – 75
4-20-30	8 – 2½	58	68 – 50
4-21-30	8 – 5	58	68 – 50
4-22-30	8 – 7½	58	68 – 25
4-23-30	8 – 9½	58	68 –
4-24-30	8 – 12	58	68 –
4-25-30	8 – 14½	58	68 –
4-26-30	9 – 1½	58 – 25	67 – 75
4-27-30	9 – 2½	58 – 25	67 – 75
4-28-30	9 – 5	58 – 75	67 – 50
4-29-30	9 – 7½	58 – 75	67 – 50
4-30-30	9 – 9¾	58 – 75	67 – 25
4-31-30	9 – 11½	58 – 75	67 – 25

Temp. at end (of air) by A. 76°.5

Dynamo not running and at temp. of air.

Temp. at beginning of ex. 76°.5 F by A.

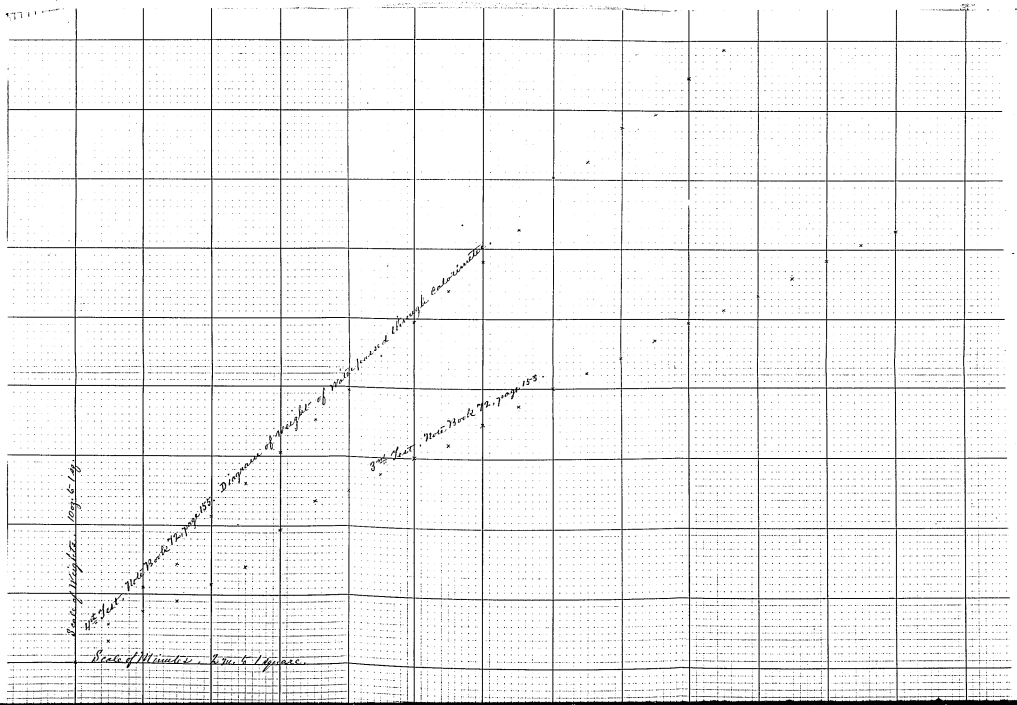
45 Test.

Warm water.

Time h. m. s.	Weight lb. oz.	Temp. of Inflow B	Temp. of Outflow A
		0F	0F
4-5-3-45	8-13	101-25	95-25
4-5-4-45	9-4 1/2	101-25	94-
4-5-5-45	9-10	101-	94-
4-5-6-45	9-13 1/4	100-75	94-
4-5-7-45	10-4 1/2	100-50	94-
4-5-8-45	10-9	100-	94-
4-5-9-45	10-13 1/2	100-	94-
5- -45	11-2 1/4	100-	94
5-1-45	11-8 1/4	99-75	93-75
5-2-45	11-13 3/4	99-75	93-75
5-3-45	12-1/2	99-	93-75
5-4-45	12-5-	99-	93-50
5-5-45	12-9 1/4	98-75	93-50
5-6-45	12-13 3/4	98-75	93-50
5-7-45	13-3 1/4	98	93-25
5-8-45	13-7 1/2	98	93-25
5-9-45	13-12 1/2	97-5	93
5-10-45	13-14 1/2	97-25	93
5-11-45	14-3 1/4	97	92-75
5-12-45	14-7 3/4	96-5	92-75

Temp. at end 76°.5 F.

[ITEM FOUND IN BOOK]



Temp. of air at beginning of test. 78 3/4°F by A.

Water in inflow at temp. of air

5th Test.

Dynamo running.

Time	Weight	Temp. of Inflow B	Temp. of Outflow A
h.m.s.	lb - oz	°F	°F
9-48-	5 - 5	73 - 5	83
9-49	6 - 5	73 - 5	81
9-50	7 - 9½	73 - 5	79 - 75
9-51	8 - 1	73 - 5	79
9-52	8 - 14	73 - 5	78 - 75
9-53	9 - 13½	73 - 5	78 - 50
9-54	10 - 10	73 - 5	78 - 50
9-55	11 - 7¾	73 - 5	79 - 25
9-56	12 - 4	73 - 75	79 - 50
9-57	12 - 15	73 - 75	79 -
9-58	13 - 10½	73 - 75	79 - 75
9-59	14 - 6	74	80 - 25
10 -	15 - ¾	74	80 - 50
10 - 1	15 - 11¼	74	80 - 75
10 - 2	16 - 5½	74	80 - 25
10 - 3	17 -	74 - 25	79 - 75

~~Temp.~~ of air at end 74 1/4°F. by A.

1.5 : 10.1 :: 10 :

1.5) 101.0 (67.3
90 0
10 5
20 5
15 0
5 0

Plate

Time	Weight	Temp. of Infusion	Temp. of Decoction
	2 lb 10 oz		
7-53-30	7 – 15	69° 5	68° 9
7-56-30	12 – 5	69° 5 air 69°	68° 9
7-59-30	15 – 9	69° 5	68° 9
8-2-30	17 – 10	69° 6	68° 9
	2 lb 5 oz		
8-5-30	5 – 9	69° 8	68° 9
8-8-30	7 – 8	69° 8	68° 9
8-11-30	9 – 14	69° 8 air 69°	68° 9
8-14-30	12 – 7	69° 9	68° 9
8-17-30	14 – 12	70°	68° 9
8-20-30	16 – 15	70° air 69°	68° 9
8-23-30	19 – 6	70°	68° 9
8-26-30	21 – 12	70° air 69° 5	68° 9
	2 lb 14 oz		
8-29-30	4 – 15	70° 1	68° 9
8-32-30	7 – 3	70° 2	69°
8-35-30	9 – 7	70° 2 air 69°	69°
8-38-30	11 – 8	70° 3	69°
8-41-30	13 – 9	70° 3	69°
8-44-30	15 – 10	70° 3	69°

?12

2 775
3 3/1550
5.7
1.2
3/0.2
5.7
5.2.2

775
2
15.50
1.6
930
1550
3/24.80.0
8.27 ft-lbs per sm.

These are taken as representing the constant heat generated in friction of C

Time	Weight	Temp. of Inflow	Temp. of outflow
8-47-30	17 – 10	70°4	69°
8-50-30	2 – 9 4 – 9	70°5	69°
8-53-30	6 – 9	70°6	av 69° 69°
8-56-30	8 – 9	70°6	69°
8-59-30	10 – 9	70°6	69°
9-2-30	12 – 9	70°6	69°
9-5-30	14 – 9	70°6	69°
9-8-30	16 – 9	70°6	69°
9-11-30	18 – 8	70°6	av 69° 69°
9-14-30	20 – 8 2 – 11	70°6	69°
9-17-30	5 –	70°6	69°
9-20-30	7 – 5	70°6	69°
9-23-30	9 – 2	70°6	av 70° 69°
9-26-30	11 – 5	70°6	69°
9-29-30	13 – 12	70°6	69°

Temp. of air 71°

After water had been running through calorimeter until 2½ P.M. a test was taken with following results.

Water passed in three minutes,

2 lbs. 4 oz.

Temp. of inlet 70°.7.

Temp. of outlet 72°.5.

72.5
70.7
1.8

7757
24
1550
1554
775.4
1.8
1403.8
775.4
3 | 3157.8
1052.6 ft. lbs. per m.

Another test gave 1029 ft. lbs.

Temp. of air 70°.

But little work, a few lamps only

Time	Weight	Temp. of Inflow.	Temp. of Outflow
9-32-30	15 - 12	70°6	69°
9-35-30	17 - 12	70°7	air 70° 69°1
9-38-30	2 - 9 4 - 6	70°8	69°2
9-41-30	6 - 2	70°8	air 69°¾ 69°2
9-44-30	8 - 1	70°8	69°2
9-47-30	10 - 3	70°8	69°2
9-50-30	12 - 13	70°8	air 69°¾ 69°2
9-53-30	15 6	70°8	69°2
9-56-30			
9-59-30			

72.5
70.7
1.8

775

775
25
3875
1550
1403.8
775.4
1.8
1550.4
3875.8
3 | 3157.8
1052.6

May 6, 1880. 2 P.M.

Test by same calorimeter.

Temp. of air. 76° F.

Temp. of inflow 71°.5 F.

" " outflow 73° F

Water in one minute passed through 1.44 lbs.

772
1.44
3088
3088
772
1112.88
1.5
1668 ft. lbs.

Work being done by current.

Much work being done by current—

2nd test— 6 P.M.

3 lb 1 oz
9.5
2 lb 8 oz

Air 75°F

Temp. of inflow 72°.3 F.

Temp. of outflow 74°

1.25
772
250
875
875
965.00
1.5
6775
965
1648.25 ft. lbs.

3rd test. 8 P. M.

Air 76°F

Inflow 73°F. 3 lb. 11½

Outflow 74°F. 9

3 lb. 2½

48.15
2 96.3
16) 25.28 / 1.58
2 3 2
9 8
8 0
1 8 5

1.58
72
3 16
1106
1106
1219.76 ft. lb.

4th test. 16) 19 / 1.2
2
30

Air 75°.5 F.

Inflow 73°F

Outflow 74°.3 F

73.2
1.2
1 5 8 4
73 2
9 1 8 4
3 7 9 8
3 1 2
1190.8 ft. lb.

5th test.

Air 76°F.

Inflow 73°.7 F.

Outflow 74°.1 F.

2 lb. 2
9
11 lb. 7

1.44
72
2 8 8
1 0 0 8
1 0 0 8
1112.16
1.

1112 ft. lb.

16) 23 / 1.44
16
7 8
6 4
60

11.25
11.25
56.25
22.50
11.25
11.25
125.625

29.5
29.5

870.25
126.5625
743.6875 / 27.27

47) 343
329
542) 1468
1254
5487) 36875
34129

F. J. J.

27 1/4
13
14 1/4

1.65
.771
1.65
115.5
1.155
1.272215
.1272

John

9/12 = 37/48

48) 378 (.771
336
420
336
840

9.75
1.65
48.75
58.50
9.75
57.525

1.272 cu. ft.

The Central Station Plant.

May 8, 1880.

.771
.16
4626
771
1.2336

1.234 cu. ft.
Weight - 555 lbs.

450 lbs.
1.234
1800
1350
900
450
555.300

Cast-Iron

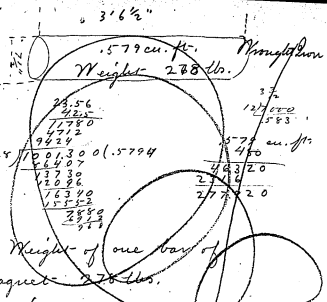
1.68
.771
168
1176
1176
1.295528

1.295 cu. ft.
Weight - 583 lbs.

1.295
450 lbs.
6475 0
5180
582.750

Total weight -

for both fields 1138 lbs.
For three magnets 3414 lbs.



28.56
9.25
1780
4712
9824

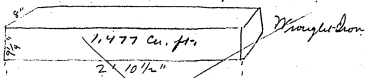
1728 | 1001300 (.5794
864 07
137 30
120 96
163 40
155 52
7888
7776
112

12 | 000
583

.579 cu. ft.
480
4632 20
2 7 7 6
277 6 20

Weight of one bar of magnet 278 lb.

Weight for three magnets 1668 lb.



9.25
74.00
34.5
370
296
222

1728 | 25538 (1.477
1728
8250
8064
1338
1209
12840
12096
744

1.477
480
118160
5908
708.960

Weight of one top bar 709 lb.

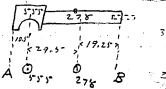
Weight of three magnets 2127 lb.

Total weight of iron in the three magnets

3414
1665
2129

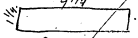
2240 | 7209 (3.2 Tons.
6720
4890
4480
4100

19.25
2.75
1400
13475
3850
53 51.50



48.75
5.55
2437 5
2437 5
2437 5
2705 6.25
53 51.50

59.25 | 32407.75 (547 lb. will be the entire
2962 5
2782 7
2370 0
4125 pressure at A for one magnet. This is distributed over a surface of 11.6 sq. in. which gives a pressure of 47 lb. per sq. in.



9.25
1.25
4625
1850
925
11.562 5

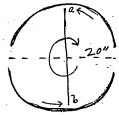
11.6 | 547 (47
464
830

555
10.5
2775
555
5825.5
1120
59.25) 18897.5 (286 lbs.
1185.0
50.875
47400
3575.0

275
40
11120

547
286
833

The weight pressing on B which is an 1½" bolt will be 286 lbs.



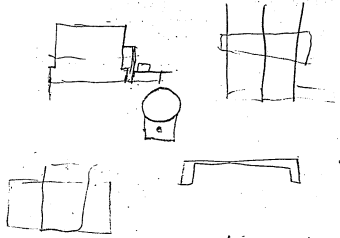
120 H.P.
33000
360000
360
39600000 ft. lbs

If it revolves at 600 per m., the circumference being 62.832, the speed at circumference will be 3142 ft. per m.

62.832
600
12/37699200
3142

and as 39600000 ft. lbs are to be exerted in this time it will require a magnetic resistance at the circumference opposing revolution equal to 1260 lbs. half of which

3142) 39600000 / 1260 or 630 lbs. is the resistance of the field at each pole.
3142XXX
8780
6284
18960
18852
1080



The rule for finding the diameter of a shaft is $d = \sqrt[3]{\frac{fWL}{T}}$. where d is the diameter, f the factor of safety, W the load of torsion, L the lever arm, T a coefficient, determined by experiment, f. be 9800 for wrought iron and 15.000 for steel.

$$d = \sqrt[3]{\frac{8 \times 1260 \times 10}{15000}} =$$

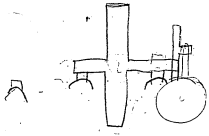
12600
8
100800

3/5.00346053
1.66782018

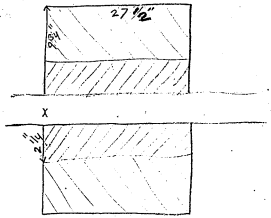
3/4.1760913
1.3920304

4.60540
24662

24662)460540 (1.88 inches diam. for
24662
218780
197296
214840
197296 shaft.



Armature



95.0625
5.0625
90
3.1416
80
282.7440

283
27.5
1415
1981
566
1728 / 7782.5 (4.5
6912
8705
8640

45
45.0
2250
180
2025.0

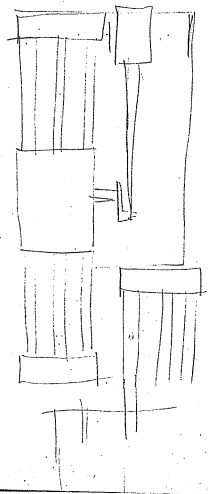
Weight of iron in armature 2025 lbs.

3.1416
19.5
28270800
25132740
31416
78.5398 / 615.4752 (.7854
5346
666
639
9216
3240
3372

3.1416
18.5
157080
251328
31416
78.5398 / 581.6328 (.7854
5346
3971
3372
599

2 (9 1/2
4 3/8

19 3/4
17 1/4
2 1/4



Questions to ask Mr. Porter.
How do you intend to provide for the lateral motion of 1/8"?
What are you going to make the dimensions of shaft and why? Weight of armature to be considered and also the tremendous strain due to the attraction of a field when the mass of the armature happens to be out-of-line, amounting to many pounds.
Sudden strain resulting from short-circuiting, very great. What will be the weight of your engine and bed with sole plate complete. What do you think of the direct supporting of the heavy weights by pillars as compared with trussing.

How about the arrangements for distributing steam, for settling the water and for returning it to the boiler?

How about head and tail arrangement of dynamo and engine and which end is to be turned toward the passage way.

Straight side for commutator pillow block.

Use two pillow blocks only. Do you not only make your shafting strong enough for torsion but also much larger to render it perfectly stiff? How about placing the dynamo above the boilers on account of heat?

How about the armature

in a ferrule which is keyed to the shaft?

How about trapping the steam and does the steam in jacket flow through or is it condensed there and returned to boiler?

Do you prefer to use the Babbitt metal in bearings and for what reason?

What would be the effect if dynamo is running free at free speed and current is instantly put on?

The inside pillow block on commutator side must be capable of removal.

Mistake in book on page 117.

1860
.22
3720
3720
409.20

1662
2234
3894 lb. cast-iron
.184
$15.5776

38
316
3800
114
117.80
34
316
.10
15

3105
2160
5265 lb. forging
.05
$263.40

800 lb. copper
555 lb. copper
.33
2220
1665
$188.70

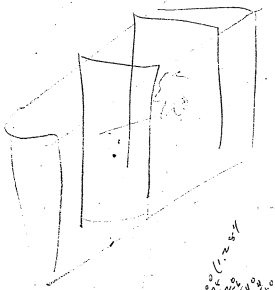
200 lb. brass
.30
$60.00

218)450($2.06
218
200

957
380
1367 lb. zinc
.09
6
$136.7
60.
188.
263.
156.
$803
.60 Soapstone
~~300 Stator~~
409 Thin Plate
~~114~~ Copper in armature
$1690

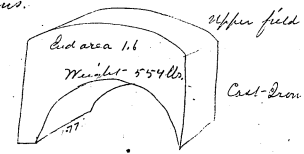
700) 3600 (5.
2800
700) 800 ($8.40
560
300
9) $15.20
$1.77

)75000



75) 1200 (1.60
75
450
450

Calculation of weights of dynamo - for cruise station based upon completed plans.

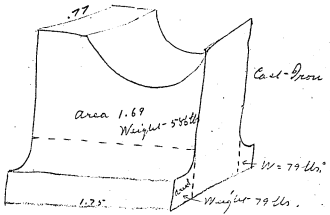


1.6
.77
112
112
1.232
450 lbs.
6 1600
4928
554400

Weight of one field 554 lbs.

Weight of 3, 1662 lbs.

1662
2232
3894



1.69
.77
1183
1183
1301.3
450
585650
5265.2
5865.50
1.58
744

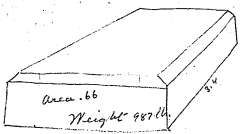
1.75
.45
875
700
787.50
787.50

Weight of one field 744 lbs.

Weight of 3, 2232 lbs.

2.4
.31
7.44
32
477) 7.44
.77
2.30

4.26
.66

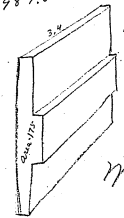


Zinc base,

3.4
.66
204
204
2.2 44
4.40
88760
88760
987.360

Weight of Zinc base under field.

987 lbs. See page 193.

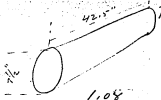


Brass plate for field.

1.75
3.4
700
525
5.95 0
5.04
2380
2975
2975.80

Weight of brass plate

300 lbs.



Wrought-Iron

44.18
4.215
22090
8836
17672

1.04
4.80
8640
432
5.18.40

1728 / 18776.5 (1.08
1728
14965

Weight of one core

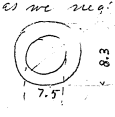
518 lbs.

Weight of 6,

3108 lbs.

This is wound with three coils of No. .10 wire (.134 diam).

If we suppose the diam. of the core to be increased by 6 × .134 and find the contents of the coil ferrule it will be approximately correct as we neglect the cotton covering.



68.89
56.25
4 / 12.64
3.16

3.1416
12.64
1256
126
3.1416
4 / 39.7098
9.9275

39.71
42.5
19855
7942
15884
1728) 168776 (9.77
15552
13225
12096
11516
1116

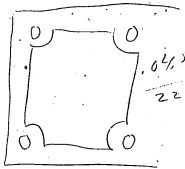
4 2.5
9.93

4 (9.77
.244

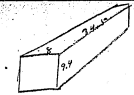
.244
548
1952
876
1828
133.712 lbs

Weight of copper wire for 6 coils.

804 lbs.



.04.5
5000
225.000



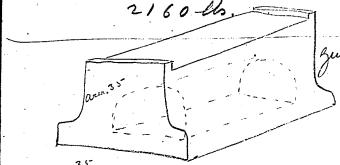
Weight of 3 75.4
9.4
75.2
34.5
3760
3098
2254

1728) 2594.40 (1.5
1728
8664
8640

1.5
4320
1200
6.0
7200 lbs.

And for 3 magnets

2160 lbs.



.35
.35
175
105
.8240
35000
35000
385.000

Weight of Brick base

385 lbs.

1662
2232
300
3108
804
2160
10266 lbs. air iron, brass, copper wire
798
385
2240) 11449 lbs. including zinc bases.
11200 5.1 tons.
2490

5.6
300
1680.0
7811.4
6526.8
1688.4

5.5-4
41.7
38778
2276
2803.5
3
7811.4

3108
21
3108
6216
6528.8

804
21
804
1608
1688.4

4.7) 17706.6 (3768
141 ×
360
329
276
252
346

3768
2232
6000
798
6798

2106
2160
4266
385
4651

1662
300
3108
804
5874
3768
2106

Weight on Innative Zinc

Weight on blue zinc

Total

with zinc. 5.1 tons.

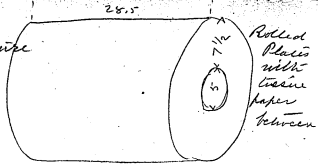
Sum of areas .35 sq. in

1.2
.35
60
36
.42 sq. ft.
440
1680
168
189.80 lbs.

987 - 189 = 798 lbs

Weight of field base.

Armature

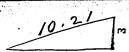


Rolled Paper with insulation paper between

314.16
19.64
294.152
28.5
1472280
2356616
589304
1728 / 8393.820 (4.86 cu. ft.
6912 ×
1851 8
1382 4
994 2
864 0
1302
450
24300
1944
2187.00 lbs.

Weight of armature iron 2187 lbs. plus 300 lbs. of copper, total weight 2487 lbs.

without shaft.



.737335
60
44.24016
6 1/3
2654406
147467
2801873

95.0625
9
104.0625 (10.209
202) 406
406
2040) 225.00
10.86
10.86
6516
8688
10.86
117.9396
2801873
2358
9432
2358
2753.76 / 3303.55 (12
2753.76 ×
549798
550752

120

500

408
10

10) .408 (.0408
80

1/5

500) 2.04 (.408
200
400

120
2
240

1240

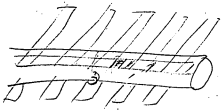
305
60
3050
9150
610.50
610.5
6106.5
6106.5

1 / 154585
10919

5 / 86944
17399

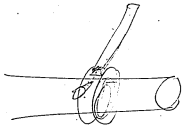
9 / 48233

249.8 lbs. pressure
400°.7 Temp.
Units in Water 406.912
Latent units 829.258
Total in Steam 1236.
Weight of cu. ft. .509



120.3 lbs. pressure
Temp 349°.95
Units in Water 354.05
Latent units 866.6
Total in Steam 1220.68
Wgt of cu. ft. .304

Pressure 14.696 lbs.
Temp. 212°
Units in Water 212.9
Latent units 965.7
Total units 1178.6



$P \propto \frac{1}{V}$

$P = c\frac{1}{V}$

$PV = c$

2)10(.5

5)120
24

10

10)240
24

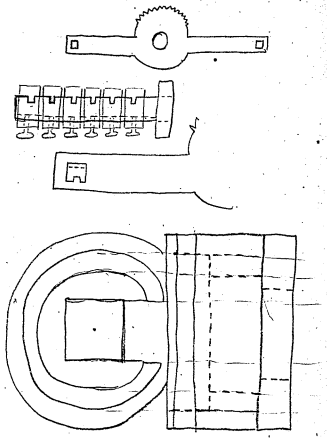
log 1.609
1
2.609
24
10436
5218
62.516 Cu. ft. .304

log 2.303
1
3.303
24
13212
6606
79.272 Cu. ft. .509

.255

1221
.304
4884
3663
371.554
6.26
22226
742
22226
2322.46

1236
.255
6180
6180
2472
315.180
79.3
945
2535
2205
249 79.5



370.0045
32
338.0045
.305
1690225
1014135
103,103225

1091.7
1194.5037
32
1226.5037
772
1.25
3860
772
381060

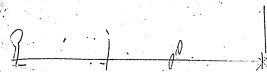
320.821
32
88.821

385.671
32
353.671
.305
1768355
1061013
107.8696555

1091.7
32.
1231.5

.695
.180
55600
695
125.100

1091.7
125.1
966.6



$x : a^2 :: x - z : z^2$

$z^2 x = a^2 x - a^2 z$

$x(z^2 - z) = a^2 z$

$x = \frac{a^2 z}{a^2 - z^2}$

$\frac{z(80)^2}{6}$

62.4
62.4
24.96
12.48
3744
3873.76
968.44

111.5
111.5
557.5
111.5
111.5
12433.25 / 149.6
1495
2938
2989
3873.75

111.5
50
31.5

31.5
31.5
157.5
31.5
945

111.5
50
31.5

50
6214
17.6

2 / 799.2.25 / 799.12

.04
.04
.66

.11
.13
.02
.22
7704
.02
.92
.62
.62

.56
.56
.56

.5210'

.1400'

.0.58
.8
.521

70711
14142

42426
14142

43284
14142

44721
14142

45826
14142

48990
14142

46904
14142

45426
14142

58310
14142

59161
14142
55628
14142

70711
20
84883 / 6568.80 (66.7
509.168
565200
509.165
550.3.2

51962
14142
52920
14142

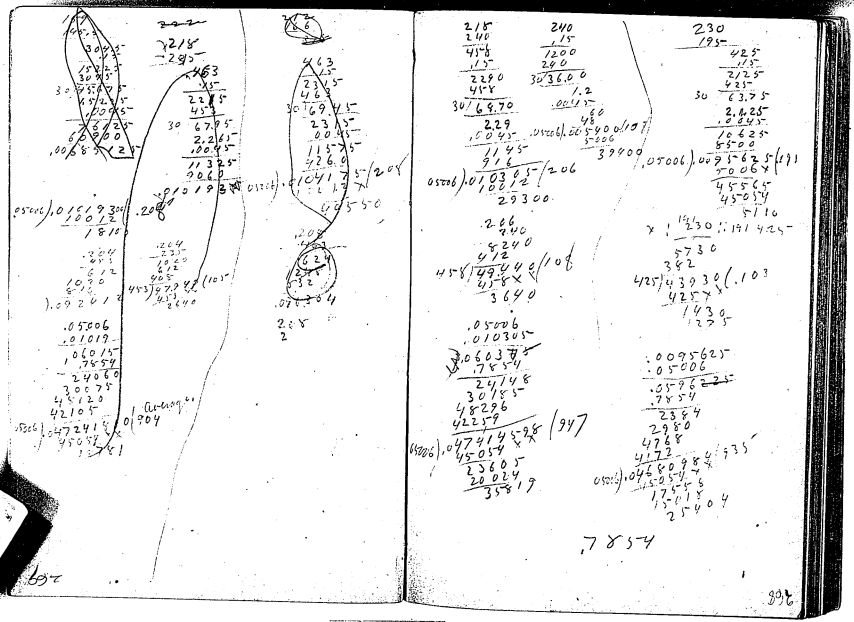
53852
14142

55678
50
698820 / 44556240 (63.8
41892.20
2663000
2095960
3552800
50
3.5858 / 3552800 (111.5
3552800
41720
35858
55560
35858
197620
177290
18.

a = 17, x = 59.6
a = 18, x = 60
a = 19, x = 60.4
a = 20, x = 60.8
a = 21, x = 61.1
a = 22, x = 61.5
a = 23, x = 61.8
a = 24, x = 62.1
a = 25, x = 62.4
a = 26, x = 62.6
a = 27, x = 62.9
a = 28, x = 63.1
a = 29, x = 63.4
a = 30, x = 63.6
a = 31, x = 63.8
a = 32, x = 64.
a = 33, x = 64.2
a = 34, x = 64.4
a = 35, x = 64.6
a = 50, x = 66.7

area of edge

Average .951



210
163
373
.15
1865
373
30) 55.95
1.865
.00495
93.25
7460
.05706) .00539225 (.168
5006
3386
30036
352250
168
210
1680
336
373) 33.5250 (.95
1710
1865
.00539225
.05006
.05486
7834
23380
29225
46760
45915
.05706) .0957906630 (.917
45054
52526
5006
3520

185
129
314
.15
1570
314
30) 47.10
1.570
.00495
785
628
.05706) .0070695 (.141
5006
20590
20140
1950
.0070695
.05006
.0486792 (.896
40045
48219
45054
3165

164
108
272
.15
1360
272
30) 40.80
1.36
.00495
680
544
.05706) .006120 (.122
5006
1140
1006
1280
164
108
328
164
272) 20.08 (.74
1904
9680
.006120
.05006
.05618
7854
22472
28090
44944
39326
.05706) .0491237272 (.861
40045
40757
40045
7697

163
100
263
.15
1315
263
30) 39.45
1.315
.00495
6575
5266
.05706) .0089175 (.116
5006
91390
163
.15
7304
163
263) 18.23 (.73
1841
9224
7363
1350
.00589175
.05006
.05589
7854
22392
27990
47784
39186
.05706) .0093566692 (.164
40045
33486
35042
41449

223
232
455
135
2275
455
30)16825
2275
.00455
11375
9100

05006).0102375 (204
10212
225550
20024
25

223
204
592
446
455)44592 (~~204~~
41005 × 100
4092
4004
3370
3325

.0102375
.05006
.06038 ~~225~~
.78558
24112
30055
4824
42221
05006).047335962 (946
45054 × ×
230556
200224
30322

200
222
422
.135
2220
6220
30)6330
211
.00455
.00455
8884
4440
4440
48420

199
200
422)35000 (90
3798
20

.0094995
.05006
.0595568
.78554
23824
29780
47648
41692
05006).0477892 4 (0934
5005 ×
4748
45054
17244
15015
22260

167
203
370
185
185
37
30)5555
185
.00455
925
740
05006).008325 (166
50006
33190
30030
31540

167
166
1002
1002
167
370)27722 (75
2590
1822
1850

.008325
.05006
.058389 ~~95~~
.78554
23356
29195
46712
40873
05006).045859506 (916
45054 × ×
80055
50006
30490

130
178
308
135
15540
308
30)4620
1554
.00455
730
616
05006).006930 (138
50006
19240
15015
42220
40045
130
130
1140
135
305)17940 (58
1540
2540
2440

.00693
.05006
.05699
.78554
22796
28995
45592
39893
05006).044759946 (894
40045 × ×
47119
45054
20655

119
159
278
.15
1390
278
.30 41.70
139
.00445
695
556
.05006) .006255 (125
5006
12490
10012
24780

119
125
595
238
119
278) 14875 (54
1390
9375
5304
741
.006255
.050006
.05006) .056222 (1
.78554
224885
281110
449776
393354
.05006) .441555158 (882
400445
410710
400445
10238

125
80
278) 12500 (45
11127
1300

104
156
260
15
1500
260
3) 39.00
13
.00535
65
52
.05006) .005850 (117
5006
84490
5006
393440
104
117
728
104
156
260) 12165 (47
1040
17685
1560
208
.005850
.050006
.05556
.78554
22336
27954
44772
39113
.05006) .043903856 (877
400445
385558
350445
35116

937
946
934
916
894
852
877
947
935
917
856
851
878
13) 11854 (912
117
15
13
24
26

010305
.020305
2) 020425
01027

.0095-6
.009495
.018015
00833

.00707
.00693
2) 08400
00700

1000
211
12111
.78554
44844
60555
96888
8477
951.

1000
994
878
858
872
462
211
7) 5486
.741

00833
00833
2) 016672
00836

.00612
.00622
00619

00592
00595
2) 01177
00589

3.1416
5.1
3.1416
2260
157080
150.2216

5.1
5.1
5.1
2.5.1
260

3,1416
2601
3,1416
188496
62832
8171.3016

$dA = y\,dx$

$dA = \frac{y\,dy}{\sin x}$

45.0 · 700

$y = \cos x$

$dy = \sin x\,dx$

$dx = \frac{dy}{\sin x}$

1.00000
.996
.985
.966
.940
.906
.866
.819
.766
.707
.643
.573
.500
.423
.342
.259
.174
.087
0

3,1416
2
4 | 6.2832
1.5708

19 | 11.951
11 1 88
557
57

1.0000000
.9999989
.9999958
.9999905
.9999831

1,0000000
.9961947
.9848078
.9659258
.9396926
.9063078
.8660254
.8191520
.7660444
.7071068
.6427876
.5735764
.5000000
.4226183
.3420201
.2588190
.1736482
.0871557

19) 11.9518826 (
114
55
35
174
19
88
36
122

$y = \cos x$

$dA = y\,dx$

$dA = \cos x\,dx = 2 \cdot \sin x$

$\int_{x=0}^{x=1.5708} dA = \sin 1.5708 - \sin 0$

$= 1$

1,5708 / 1.00000 (

90 / 1.00000 (.01111111

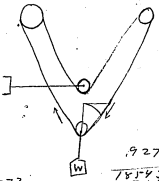
90
100

1.5708 / 1.00000 (.636618

94248
57520
57124
103960
94248
97120
94248
28720
15708
13012
12564

5664
12
67968
20.44
67968
67968
611712
6126 59695

$P = \frac{W}{2\cos\phi}$



314159
38
2513272
942477
111.262 | 119.3982 42 (1.073
111.262 ×
5 11842
77 5834
3 30080

.927184
12
1 5 5 8 3 6 8
927184
11 126208

1880
2.073
5640
131760
1880
2017.240
27.15
1005620
201724
1 47 1068
403448
5476 8066

2017.24
39.25
1005620
403448
806896
60517 2
6 0 9 0 4 7

136.24
2281
13 62
10896
2724
2724
3 1 0 3 6 762

691) 6120 (88.6
5528
5920
5528
3920

9991.2
911.32
2782.63
411.315
752
82 6130
205 7535
2892 2 63
3 1 0 5 2 7
5 5 2 6 0 7
3 3 7 4 8 3
3 1 0 6 9
5 3 2 7 7 1 0 3 7

752) 2254 (3.0332
2256
2500
2256
2440
2256
1840

.0606
629
5454
1212
3636

05-006) 381174 (761
3 5 0 4 2 ×
3 6 7 5 4
3 0 0 3 6
7 1 8 0

06637
629
54333
12074
36222

05-006) 3767 7 3 (7 5 8
3 5 0 4 2 ×
2 9 3 0 7
2 5 0 3 6
4 2 7 7 3

.05996
629
53 6 4
1192
35 7 6

05-006) 37488 4 (749
3 5 0 4 2 ×
2 9 9 6 4
2 0 0 2 4
9 4 4 0 0

2281
752

5664
1880

05-006) 5277 3 (7 6
4

05-006) 3676 5 0 5 (7 3 4
3 5 0 4 2 ×
7 2 3 0
3 5 0 1 8
2 2 1 2 5

05-713
629
5 9 4 1 7
1192 6
9 4 2 7 8

05-006) 35 9 3 4 7 7 (7 1 8
3 5 0 4 2 ×
8 9 2 7
5 0 0 6
3 9 2 1 7

1880) 5664 (3.013
5640
2400
1880
5 2 0 0

056,18
629
505562
18236
33708

5026) 353372 2(706
31-042 ×
29522

3,141616
942248
53336
8,99484

22,63
5,71
197,20
28,04
169,46
2,53
7,71
,07
172,77

05-9,5
6,35
50382
1196
33588

5026) 35-2 11 42 2(703
31-042 ×
16942

5-42,25
5,35
21700
43400
26125
306,82200
,00 22
61364
61364
,67500 4

3,14159
3,14
9,92477
52360

1,072
6474
1072
1,726 9) 168

,927184) 9,9448370 (10,729
927184
676530

,927184) 9,9448370 (10,729
927184×
6765300
6490288
2750120
1654368
8957520

,000
,017
033-927184) 99484
052
,927184) 9,9448400 (10,729
927184
101-
122
139
156-
174
191
208
225-
242
259
276
292
309
326
342
358
375-
391
407
423
438
454
469
485
500
515-
530
545-
560-
575
590-
605-
620-
635-
650-
665-
680-
695-
710-
725-
740-
755-
770-
785-
800-
815-
830-
845-
860-
875-
890-
905-
920-
935-
950-
965-
980-
995-
1010-
1025-
1040-
1055-
1070-
1085-
1100-
1115-
1130-
1145-
1160-
1175-

36 2 6 2 7

1009 9 3 4

339 8 9 2

109 9 4 40

70 2 9 15

70 1 4 6 6

81 3 8 8 8

29 4 8 5 2

5 5778394

642

.0000
.052
.105
.156
.208
.259
.309
.358
.407
.454
.500
.545
.588
.629
.669
.707
.743
.777
.809
.839
.866
.891
.914
.934
.951
.966
.978
.988
.995
.998
1.000

30 1.9595

653 2

2 3.1415927

1.5707964

4570

6301

8724

9595

25-2

1.5707964 / 1.000000000 / .63662
94247784

27.15
1.884
277200
27120
2715
51042
10.7297
357284
455378
102084
357284
51042
5776650874

575522160
471238920
103982680
94247784
7734896
94247784
3101176

5618
6366
33708
337708
16854
33708
1016 / 31764188 (714
33042 ×7
7221
7106
22158
1000

1.8038666

7824726
5863392
8868484 — 771.

7808212
5846878
8851970 768

7752463
5791129
8796221 758

7667845
5706511
8711603 743

7568642
5607308
8612900 727

7495817
5534483
8539575 714

7480329
5518995
8524087 7 / 5193 712

742

994.2
771.75
2/222.45
111.325
3.83
889800
33 36 75
111 325
372 75
1538.6
172
30772
107702
15386
264649
10.73
2939968377
264649
10.7287
185 25 43
238184 1
529298
185 25 43
264649
2639604 3
14566.5
44.25
7283 25
891330
582660
582660
6445681.625
7.35
3867908
8924
3159
1053
14566.05

5-1042) 5-47666 (10.73
5-1042
372460
372284
151660
102084
495760

264649
10.73
2939947
185 25 43
264649
2639968377

264649) 2 8446 50 (10.7
2 6 46 49
1981100
185 25 43
1285570

168) 1053-1046
1008
451
336
1150
1008
1424
1424

994.2
771.75
2/222.45
111.325
3.83
889800
33 36 75
111 325
372 75
1538.6
172
30772
107702
15386
264649
10.73
2939
185 25 43
264649
2.72
2715
1850
217200
27720
2715
51042

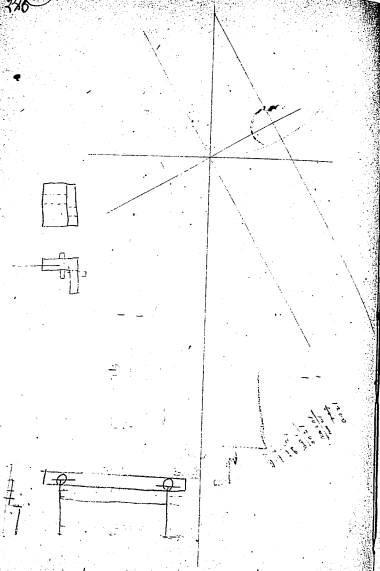
1.072
64774
1073
172.49
17249
1035 84
1053
473.83

3/4" vacuum,

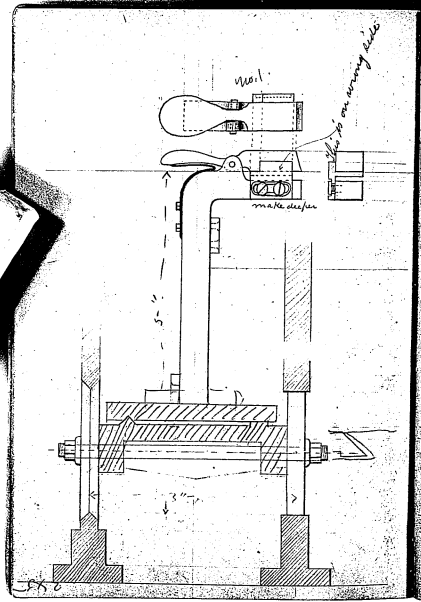
even at 120°,

~~220°~~ at 200°

994.2
911.57
2/82.43
41.315
82630
206575
2892.05
3/069
10.7297
217483
279621
62138
217483
3/069
53336107



Mr Barnes


wool
file to run nearly flat
make deeper
5"
3"

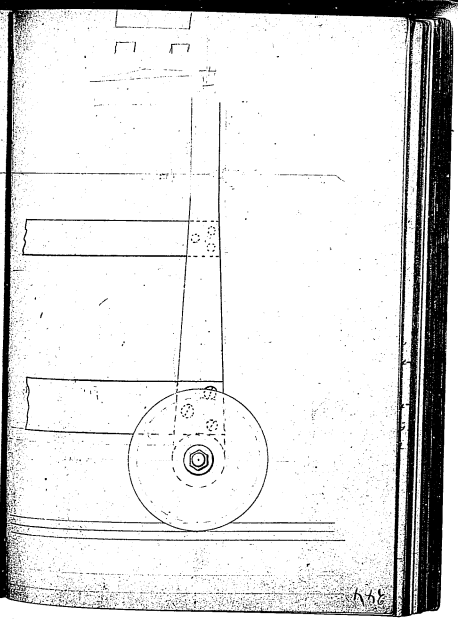
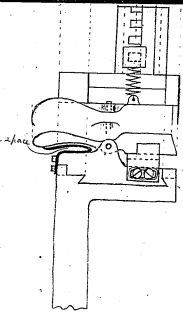
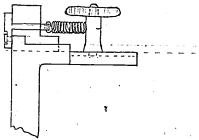
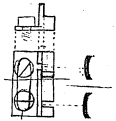
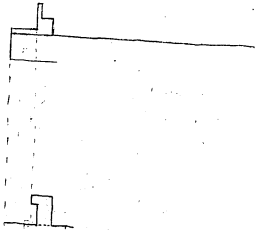


Fig. 1.


Stirrup to prevent
from coming out
of groove.
Yellow space







.047
.0325
.0145

.102
.011
.0455

.079
.034
.045

.079
.034
.045

Plates
gauge

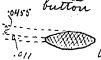
239

March 31, 1880

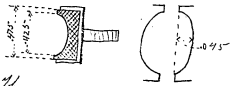
Notes on telephone.

S. H. Short.

Average diameter of Carbon button .425 inches.

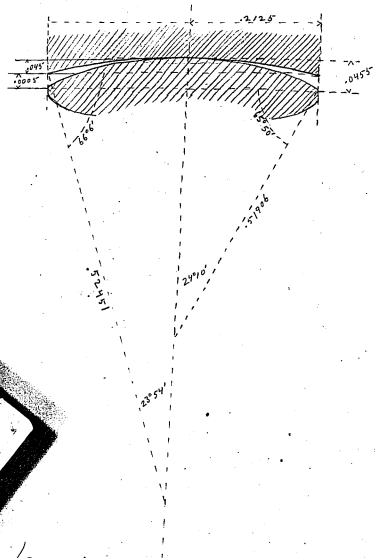


Thickness in center .102 inches.
Average thickness on edge .011 inches.



The measurements of the lens were carefully made with a Brown & Sharpe wire gauge. The cup was measured in the same manner by means of a wax cast, the wax, covered with tissue paper being firmly pressed into the cup. The results are the of several measurements most of which were exactly alike.

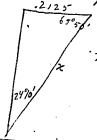
238



.2125").0455000 (.214118
92500
3000
87500
85500
2000
1925
3750
2125
16250
12875
1375

77°55'
12° 5'
65° 50'

90°
65°50'
24° 10'



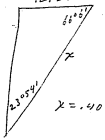
x : 1 :: .2125" : .4093923

x = .4093923). 2125000000 (.519906
2093923 51
7803850
4093923
3709927 70
3683538 07
2539 63000

.2125").0455000 (.211765
42500
2500
2125
3750
2125
16250
12875
13750
12750
10000
8500
1500

78° 3'
12° 57'
66° 6'

90°
66° 6'
23° 54'



x = .4051416) .2125 0000 (.52457
2025 7080
8829200
6202832
1726 3680
1620 5664
20580160
20257080
323 0800

9657.7
772
19314
67599
67599
7455204

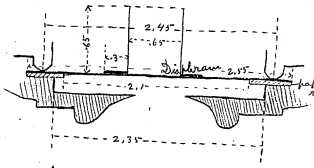
Hot 2
1644
.03797
11508
14796
11508
9332
62422 68

.03797) 1.00000 (26.3
75895
29660
22782
12780

1.644) 1.00000 (60.827
98664
13600
13704
4980
3286
17920
11508
6412

1 .21183) 1.00000 (4.7
84732
15268

Short Telephone in Section.



Mr. Shaw assumes that, the diaphram being firmly held at the edge, it is of the nature of a beam firmly fixed at both ends.

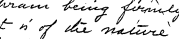
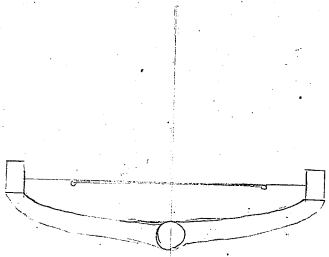
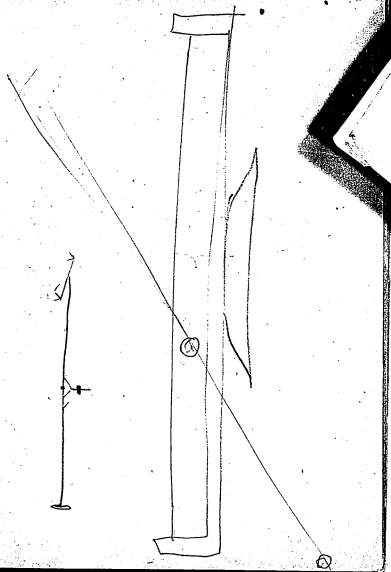


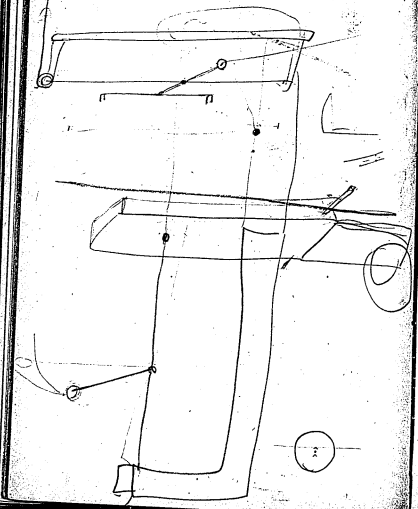
Fig. A.

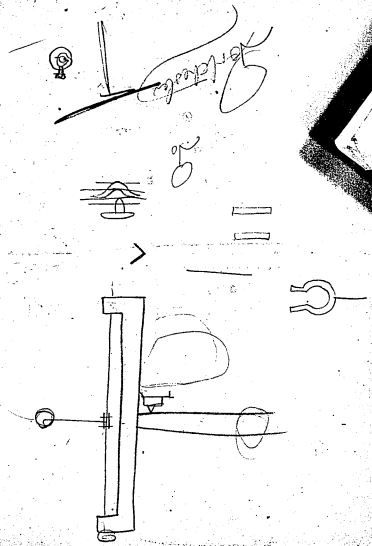
When it is uniformly loaded the points of contrary flexure are as shown in fig. A.

When the load is in the center, which is practically the case with the telephone as the mouth piece protects all excepting the center from the sound waves, the









1229
2
238

relative position of the points of inflection are as shown in fig. B.

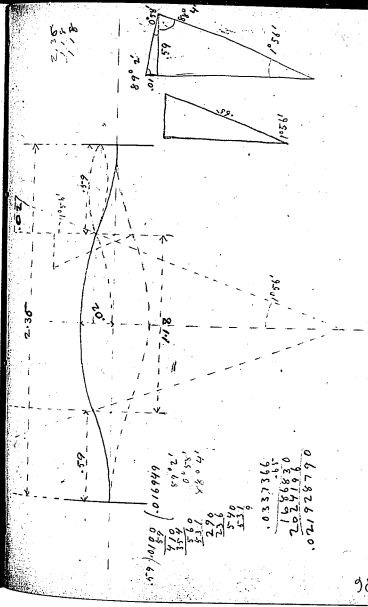
Fig. B.

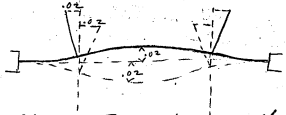
This is assumed to be the case in the following investigation.

Mr. Short states that by placing

the arms which hold the cups at the points of contrary flexure he gets more motion at the carbon button than he would from direct motion at the center of the diaphragm.

I assume that the diameter of the diaphragm begins with the edge of the wooden frame and is 2.36 inches long measurement. The height to the center of the cups is .65. It is also assumed that the cup supports are in the most favorable position, that L = 0 is at the points of flexure


2.36
.65
.65
.65



which actually is not the case. The result is exactly the same as for direct motion of the center of the diaphram.

As the supporting arms are actually placed in the telephone which I examined, they are not so favorable to motion. The feet which are wide complicate matters as also the solder and heat from soldering.

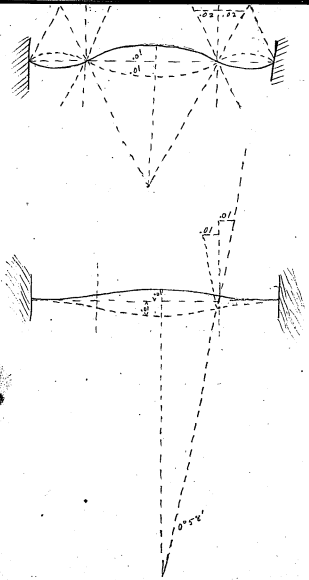
I find that when the arms are placed the ferrotype is raised as shown which makes the action uncertain.

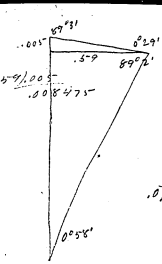
By making the arms

longer the motion would be greater, or less with shorter arms, but longer arms would interfere with quick action on account of inertia of parts.

This arrangement is a positive disadvantage as it gives no gain in motion and complicates the parts, besides necessarily being more sluggish than direct center-diaphram motion.

By experiments, April 2, 1880, I find that the analogy of the beam fixed at both ends is in no respect correct but ~~that~~ the diaphram vibrates in such a manner as to form nodes, part of the surface being on one side and part on the other of a straight line joining the circumference at opposite points.





90°
0°29'
89°31'
89°31'
0°29'
89° 2'
90°
89°2'
0°58'

.0168707
.125
843535
10122424
.0109635955

Experiments were made, April 2, 1880 with a ferrotype diaphram and the following were the shapes.

High falsetto
Diaphram lovely held.
Clarke.

High falsetto,
and very loud.
Diaphram lovely held.
Clarke.

High falsetto,
Diaphram loosely held.
Lawson.

Gruff falsetto and tremulo.
Lawson.
Diaphram loosely held,

High clear tone,
Diaphram loosely held,
Clarke.

Middle register
Diaphram firmly held,
Clarke,

The diagrams showing the positions which the sand assumed under the different sounds show that this theory

of the arms being in the most advantageous position is wrong and in fact a theory which would answer for one note would be altogether wrong for a different note, and, as far as my experiments show, not only the pitch, but the quality has a great deal to do with the form of vibrations. One important fact was ascertained namely, that the center was always one of the most active centers of vibration.

The length of a sound wave in low D is $\frac{1118}{288} = 3.88$ ft. = 46.56 in.

288)1118(3.88
864
2540
2304
2360

One cubic foot of air at 60°F weigh .0765 lbs and one sq. inch in section of this sound wave would weigh

$\frac{46.56 \times .0765}{1728} = .00206$ lbs.

If we suppose the amplitude of the vibrations to be 1/4 inch which is a most unusual case the weight of one sq. inch of air of that length would be

$\frac{.25 \times .0765}{1728} =$

.0765
.25
3825
1530
1728)19125(.0000112 lbs and the

1728 X
1840
1728
11170

$\frac{.0000112 \times (1118)^2}{2} =$ .7 ft. lbs. per second.

1118
1118
8944
1118
1118
1118
1249924
.0000112
2499848
1249924
1249924
1399 1488

That is .7 ft. lbs Kinetic energy is equivalent to .00136 lbs potential energy on each sq. in.

If we then suppose the mouth-piece to be taken away leaving the diaphram unprotected the Kinetic energy on the entire diaphram expressed in potential energy will be

.00136
3 6
8 16
1024)1400(.001 36
3 072
3 072
6 720

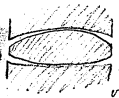
energy will be in each sq. inch

$\frac{.0000112 \times (1118)^2}{2} =$ .7 ft. lbs. per second.

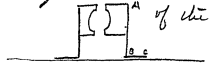
the diaphragm. This investigation has given to the Short-Telephone every advantage as to premises upon which the calculations have been made and we come out with the result that at the utmost the pressure on the diaphragm will be .096 lbs. or 1.54 ozs. and with this pressure

96
100
5
26
1.536

laying aside the fact that it is many times greater than the pressure of most sound waves, he expects to obtain more surface contact by pressure upon the lens-shaped carbon, and made of hard gas-carbon



I have omitted the consideration of the great loss in even this calculated pressure through the lever arms ABC



of the cup-supports,

I find by several careful experiments with pressure upon gas-carbon that no perceptible alteration can be seen with a pressure with the wire gauge of at least several pounds and that it takes the full man-power to compress it to the extent of two thousandths of an inch and how even the play of only five ten-thousandths of an inch in Mr. Short's lens-carbon is to be utilized is difficult to see.

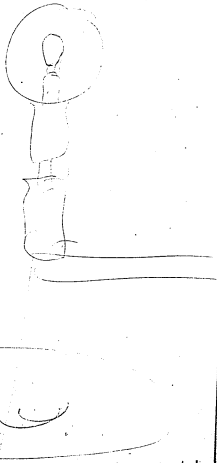
It can only be, not by changing the amount

of surface, so called, in contact; but by more or less intimate contact by pressure within the limits already in so called contact, which is the essential principal of the Edison Telephones

$$\varphi = \frac{dv}{dt} \qquad v = \frac{ds}{dt}$$

$$dt = \frac{ds}{v}, \qquad \varphi = \frac{v\,dv}{ds},$$

$$\varphi\,ds = v\,dv, \qquad \varphi s = \frac{v^2}{2}$$

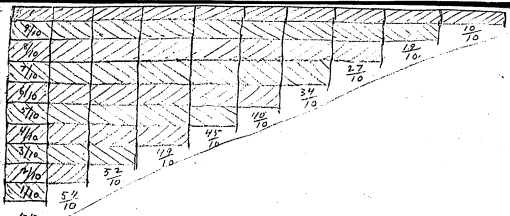


2.10

1	2	3	4	5	6	7	8	9	10
$\frac{1}{10}$	$\frac{1}{45}$	$\frac{3}{80}$	$\frac{2}{21}$	$\frac{1}{12}$	$\frac{2}{15}$	$\frac{7}{40}$	$\frac{4}{15}$	$\frac{9}{20}$	1

2520, 560, 945, 2400, 2100, 3360,

10/10, 45, 80, 21, 12, 15, 40, 15, 20
15 1, 45, 8, 7, 12, 15, 4, 15, 2
4/1, 3, 8, 21, 12, 1, 4, 1, 2
3/1, 3, 2, 21, 3, 1, 1, 1, 2
2/1, 1, 2, 7, 1, 1, 1, 1, 2
1, 1, 1, 7, 1, 1, 1, 1, 1



Total areas $\frac{55}{10}$

Resistance $\frac{10}{55}$	$\frac{10}{54}$	$\frac{10}{52}$	$\frac{10}{49}$	$\frac{10}{45}$	$\frac{10}{40}$	$\frac{10}{34}$	$\frac{10}{27}$	$\frac{10}{18}$	$\frac{10}{10}$
$\frac{10}{55}$									

$$10.6\left(\frac{520}{102000}\right) + 10.6\left(\frac{570}{85000}\right) + 10.6\left(\frac{244}{68000}\right)$$

$$+ 10.6\left(\frac{366}{51000}\right) + 10.6\left(\frac{366}{34000}\right) + 10.6\left(\frac{126}{17000}\right).$$

5200
6440
3660
7320
13980
7560
42000) 41560
10.6
249360
41560
102000) 440560 (4.3
408
520
29

415560
19200
193200
36) 779760
10.6
779760
779760
102000) 8277 (8.3
816
36) 8.3 (2.3
7.2
1.0
1.0

520.0
105000

2) 6, 5, 4, 3, 2, 1
3) 3, 5, 2, 3, 1
1, 5, 2, 1

3200
6440
3660
7320
10980
7560
41560
249360
41560
108000) 440560 (4.08
432
850

$$z : x^2 :: a : (z-x)^2$$

$$ax^2 = z^2 - 2zx + zx^2$$

$$(a-z)x^2 + 2zx = z^2$$

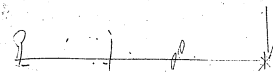
$$4(a-z)^2x^2 + (-) + 4z^2z^2 = 4z^2(a-z) + 4z^2z^2$$

$$= 4z^2(a)$$

$$2(a-z)x + 2z = 2\sqrt{az}$$

$$x = \frac{\pm\sqrt{az} - z}{a-z}$$

$$x = \frac{z(\sqrt{az} - z)}{a-z}$$



$x : a^2 :: x - 2 : 50^2$

$2^2 x = a^2 x - a^2 2$

$x(2^2 - a^2) = a^2 d$

$x = \frac{a^2 d}{a^2 - 2^2}$

a = 17,	x = 59.6
a = 18,	x = 60
a = 19,	x = 60.4
a = 20,	x = 60.8
a = 21,	x = 61.1
a = 22,	x = 61.5
a = 23,	x = 61.8
a = 24,	x = 62.1
a = 25,	x = 62.4
a = 26,	x = 62.6
a = 27,	x = 62.9
a = 28,	x = 63.1
a = 29,	x = 63.4
a = 30,	x = 63.6
a = 31,	x = 63.8
a = 32,	x = 64.
a = 33,	x = 64.2
a = 34,	x = 64.4
a = 35,	x = 64.6
a = 50,	x = 66.7

$$x = \frac{80\sqrt{a}}{\sqrt{2}+\sqrt{a}}$$

$$x\sqrt{a} + x\sqrt{b} = 2\sqrt{a}$$

$$\sqrt{a}(x-2) = -x\sqrt{b}$$

$$a(x-2)^2 = bx^2$$

$$a = \frac{bx^2}{(x-2)^2}$$

$$\sqrt{a}(2-x) = x\sqrt{b}$$

$$a(2-x)^2 = bx^2$$

$$a = \frac{bx^2}{(2-x)^2}$$

$$\frac{80\sqrt{2}}{\sqrt{2}+\sqrt{2}}$$

$$\frac{80\sqrt{2}}{\sqrt{4}+\sqrt{2}}$$

$$\frac{80}{3} = 26.7$$

$$\frac{6400b}{}$$

$$x = \frac{2\sqrt{a}(\sqrt{a} \pm \sqrt{b})}{a-b}$$

$$= \frac{2\sqrt{a}}{\sqrt{a} \pm \sqrt{b}}$$

$$x\sqrt{a} \pm x\sqrt{b} = 2\sqrt{a}$$

$$\sqrt{a}(2-x) = \pm x\sqrt{b}$$

26.7

$a = 1,\ x = 33.1$

$a = 2,\ x = 40$

$a = 3,\ x = 44$

$a = 4,\ x = 46.9$

$a = 5,\ x = 49$

$a = 6,\ x = 50.7$

$a = 7,\ x = 52.1$

$a = 8,\ x = 53.3$

$a = 9,\ x = 54.4$

$a = 10,\ x = 55.3$

$a = 11,\ x = 56.1$

$a = 12,\ x = 56.8$

$a = 13,\ x = 57.5$

$a = 14,\ x = 58.1$

$a = 15,\ x = 58.6$

$a = 16,\ x = 59.1$

$$\sqrt{a} = \frac{\pm x\sqrt{b}}{2-x}$$

$$a = \frac{bx^2}{(\frac{2-x}{x})^2}$$

2.2361
1.4142

2.4493
1.4142

2.6457
1.4142

2.8284
1.4142

3.1623
1.4142
4.4720

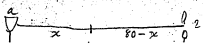
3.3166
1.4142
4.7208

3.4641
1.4142
4.8783

3.6055
1.4142

3.7417
1.4142

3.8730
1.4142
5.2872



$$a : x^2 :: 2 : (80-x)^2$$

$$a(80-x)^2 = 2x^2$$

$$6400a - 160ax + ax^2 = 2x^2$$

$$(2-a)x^2 + 160ax = 6400a$$

$$4(2-a)^2x^2 + (-) + (160a)^2 = 4(2-a)(6400a) + (160a)^2$$

$$= 51200a$$

$$2(2-a)x + 160a = 160\sqrt{2a}$$

$$x = \frac{160(\sqrt{2a}-a)}{2(2-a)} = \frac{80(\sqrt{2a}-a)}{2-a}$$

$$= \frac{80\sqrt{a}(\sqrt{2}-\sqrt{a})}{2-a} = \frac{80\sqrt{a}}{\sqrt{2}+\sqrt{a}}$$

$$= \frac{80\sqrt{a}}{1.4142+\sqrt{a}}$$

$$-4x^2 + 4a^2 = 4a^2b$$

$$a : x^2 :: b : (l-x)^2$$

$$bx^2 = al^2 - 2alx + ax^2$$

$$(a-b)x^2 - 2alx = -al^2$$

$$4(a-b)^2x^2 - (-) + 4a^2l^2x^2 = -4al^2(a-b) + 4a^2l^2$$

$$= +4a^2l^2b$$

$$2x(a-b) - xal = \pm xl\sqrt{ab}$$

$$x = \frac{\pm l\sqrt{ab}}{a-b} + \frac{al}{a-b}$$

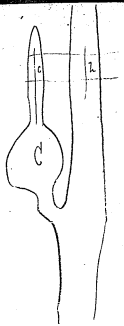
$$x = \frac{al \pm l\sqrt{ab}}{a-b}$$

$$x = \frac{l\sqrt{a}(\sqrt{a}+\sqrt{b})}{a-b}$$

$$\frac{l\sqrt{b}(\sqrt{b}-\sqrt{a})}{-(b-a)} = \frac{l\sqrt{b}}{\sqrt{b}+\sqrt{a}}$$

$$x = \frac{l\sqrt{a}}{\sqrt{a}+\sqrt{b}}$$

$x^2+y^2=R^2$	$\frac{\pi R^2}{4}$	$\frac{4\ 3.141589}{.7854}$	
.6056			
.6082	0786	3028	2846.58
6108	0789	3041	2870.81
6134	0793	3054	2895.18
6160	0796	3067	2919.66
6185	0799	3080	2944.26
6211	0803	3093	2968.94
6237	0806	3106	2993.73
6263	0809	3119	3018.63
6288	0813	3132	3043.62
6314	0816	3144	3068.78
6340	0819	3157	3093.93
6366	0823	3170	3119.24
6391	0826	3183	3144.65
6417	0829	3196	3170.17
	0833	3209	3195.78



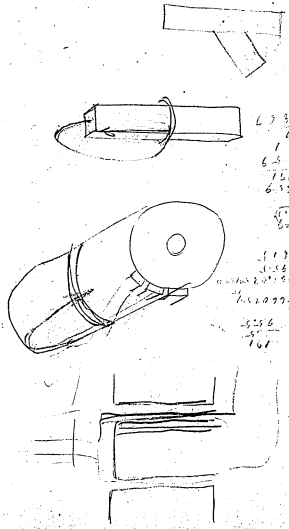
$r : 1\text{ at} :: h : 760$

$r = \frac{h}{760}$

$R : \frac{h}{760} :: c : C$

$R = \frac{hc}{760C}$

3/4" vacuum. temp.



Menlo Park Notebook #73 [N-80-02-02]

This notebook covers the period February-September 1880. It was used, probably by Albert Herrick, to keep a record of the lamps burning at the Menlo Park laboratory complex between February and May 1880. Near the end of the book is an index to the lamps. Toward the end of the book there are also a few other notes, calculations, and drawings, including one dated September 20, 1880. On pages 272-281 is a list of carbon lamps, numbered 1-248, which appears to be in Edison's hand. The label on the front cover is marked "Record of Lamps." The inside front cover is inscribed: "Notice All lamps in this book have enameled inside globes unless otherwise mentioned." The book contains 284 numbered pages.

Blank pages not filmed: 204-205, 210-211, 228-229, 234-261, 266-271, 282-283.

Missing page numbers: 13-14, 21-22, 195-196, 223-224.

No. 73 Produce

all lamps in this book have enameled inside globes unless otherwise mentioned

LIBRARY OF THE

BOARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

[illegible] Kelsey

[illegible] 1st Nov. 1896.

May 1, 1896.

3.62 [illegible]

Res 132 Ts 10

Commenced burning at — Feb 2. 1890 2.00 P.M.

Feb 2	8.00	✓
" 2	11.00	
" 3 —	11.00 noon	30.00 hrs

Burned carbon at 10 — no. 1 carbon notes see. burnt trim

burnt total carbon 132

1 s carbon	18.00
108 carbon	0.00
1 s carbon	0.00
109 carbon	0.00

3 81 Horses Huntington

Res. 125

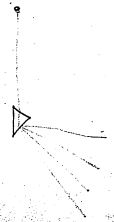
Commenced running at | Feb. 2 1880 2.00 P.M.

Feb 2 8.00
2 11.00
3 11.00 Total 30.00 hrs run

Time

Bonsted March 13 1880

Total hours 730 March 13 at 830



4

373 Warren Kennington S

Rns. 122

Commenced running at | Feb 2. 1880
2 00 P.M.

Feb. " 8.00
" 11.00
" 11.00 Total hours 20.00 hrs

Where

Buried

676 Cumdler Jem organ
Pos. 167

Feb 2. 1880

Commenced running at — 10. 00 HM

Feb. 2 2.00 total 13.00
~~2~~ 11.00
3 11.00 " 24.00 ✓
8 11.00
4 16.00 - 51.00

Cordon tube at - Pos. 7.
Enamelled cracked Edwin

579 4 Chim. from Cigar
North side

Reo 164

Commenced burning at | Feb 2. 1880
10. 00 AM.

Feb. 2 2.00
2 11.00
3 11.00 Total hours 24.00 hours

579 ——

Burning

Burned 4 3 06 ~~Total~~ hrs

10

575 Over Iron Electr. Beach 11

Iron Cem. Lab Jr. Chem

Commence Feb 2. 1880.

burning at - 11.30 AM

Res. 174. high able reading Enameled.

Feb 2 .30

2 11.00

3 11.00 Total hours 22.30

3 1.00

4 11.00

5 8.00 " " 32.30

Carbon oxydized

Carbon bike at - Carbon 7

461 Over Breuther desk
taken from stairs dining room Pro
Reo. 158
Commenced | Feb. 2 1880
burning at | Ohio 40 th
flue burned 16. 0. 15 | Barrels.

	Hours each day	Total
Feb. 2		160 See Book 74 page 185
Feb. 3	11 10	One 152 Hours

Burned the first chandelier
from organ south side

Feb 14 191 left the fourth

Burke at Pro

165. for telephone room in Court
from Services Store room
Rec. 16th

Commenced running at — Feb 2 1880
12.00 noon

Had burned 160.18 in services
Feb. 2. 11.10
" 3 11.00 Total hours 182.15 noon

Burned to Chas. over Griffiths
~~Hooks~~ Bench, on Feb. 10. 1880
over from Bethelem
after being brought from Arizona
prison for poverty

Burned by being upsetted
by accident Feb 20 1880
B.S.

83

772
772
1544
5404
5404
595984

212
72
150.

772
1200
3860
772
11200
33 | 99
170

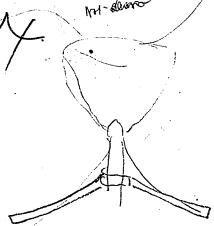
3.5

587. Astronomy
On onum ones Stroeere
1st one seine chandelier fim
organ Rs 200 Bank note

Commenced | Feb. 2. 1880
Coming at | 6 PM

Feb. 21 | 12. hours
Has hunt a total of | 14. 40 minutes

Bristol
Mr-Evans



Laboratory
547 on leading wires between
2 and third Chandelier from Organ
Res. 175 — Bro. & Test
Commenced burning at — 1 Feb 2 1880 6.00 P.M.
Up Feb 2 12 hours.
Broke after burning 0 13. 14 hours

GT

S 74 Potomac Parlor Middle

Res 136 , Feb. 2 1880

Commenced 2.00 P.M.

Running at

Feb. 2 3.30

3 3.30 Running on non.

580 In office over Mutto [illegible]
South side
Rev. 147
Commenced running at — | Feb 2 1880
9.45 - AM

Feb 2 2.15 -
3 8.00 Total 10.15 run

28

29

No. Lamps 593

Resistance 3145 –

~~Transformer~~ Clamps Fannbaugh

Carbon Minneller fiber

Sealing Enameling

Vacuum

Place In Chandelier ~~north side~~

In forward hub near ~~telephone room~~

Over Fannies Desk In Edison Changed

Date Feb	Cost day	Total hours
Feb 9	8.30	
	Finished glass bowl – about –	
	4 9 minutes	

No of Lamps 5-94 Res 195-

Carbon Nonmelter fiber

Clamps Plumbago

Sealing Enamelled

Vacuum

Position In south side first chandelier
near telephone room

Over Col. Bell Planned By Edison

Date	Minutes	Total hours	Remarks
Feb 9	8 AM		
Left off in			Second Chandelier
Began	Finished		in about 2 minutes total
Running time			

No 9 Lamp 592 Res. 427

Carbon ~~Enameling~~ Mimeoline Tube

Enameling

Sealing Enameling

Vacuum

Position On Training Desk Brone

immediately — on printing Dept.

Date	Hours worked on lamp	Total h.	Remarks

No of Lamp 375 Rec 828

Carbon Spinella Fibre

Clamps Plumbago Jar

Sealing Bunnelene

~~Position~~

Position Carrying on mines by Hanging
A pump no of receiver

Date	Motive power	Total	Remarks
			Burned 20 minutes
			Customized Fibre Tube at Pa
			7 clamps

No of Lamp 578 Res. 165 –

Carbon Large

Clamp Platinum

Sealing Enameling

Vacuum

Position Over Desk by side of long table in Lab. - removed to Lecture Room

Date		Hours per day		Total hours
Feb	2	11	00	
"	3	11	00	22 10

No of Lamp 334 Res
Carbon Large
Clamp Platinum
Sealing enamelling
Position on table by microscope
Changed after burning 6/. 30 from Ammonia

		Hours		o'clock	
Feb	3	6/	.30	6/	36	Remarks

No of Lamps 529 Res 154

Carbon Large

Clamps Platinum No. 2

Sealing Enameling

Vacuum

Carbon ~~On~~ first Lamps on ones from ~~[illegible]~~ Finishing by Lamps

Date	Hours	per	Total	Remarks
Jan 29	1	80		Commenced Forming
" 30	22	00		
" 31	22	00		
Feb 1	6	00		
" 2	10	00		
" 3	11	00	92 80	

Changed to spec in Motor size shown by Mr

Feb. 17 1880

Commenced on sheet — C.O.O.

Bustes

50 ind 43

No 8 Lamp 597 Rd 167

Barium large and very small Prunes

Clamps platinum

Lebley Burnelong

Spirits

Position as ~~shown lamp was~~

Goes to stock Clamps to Chem 1st from Tel

Elson was nugget Bennich

Date	Lamp per	Total	Times
Feb. 5	11	1,00	
" " 8			

Blasted after fusing as total

8 80 times ~~[illegible]~~ Carbon

Broke at — pour 2

619 Francis room

Boiler Commenced } 4 26.9 1880
Turning at — } 6.00 PM

Hotel Lib. Inspectors

618

Reo 150 | Feb 9. 1880
Commenced | 6.00 PM
burning at –

Busted March 4. 1880

Wire crossed wire
Carbon – good

Lens burnt –

Bill burn

Cam burning at 1.30
March 5. 1880
Taken down to photometer room

25-5-Jr Reina chamaleon
Lomo pompa
Rec 200 | Feb. 9 1880
hecho en trek muestra
Blunt Sabbkerick Kina
Blown Tom Rutherford
Bowl Feb 13 | 1880
at 10.50

Bowled at pos.'
in left-hand as stood
in chamaleon middle
between deep fine mid wicket

Total hour 150 hours

23 | 880

586 Over my old desk

Removed to room over ~~the~~ C. Bench Laboratory

Per 164

Commenced burning at — Feb. 4 1880 5.15 — P.M.

Feb. 4	7.00
" 5	22.00
" 6	22.00
" 7	22.00
" 8	22.00
" 9	22.00
	106.00

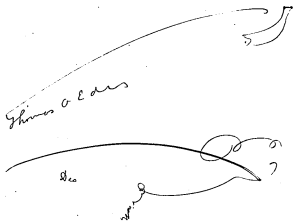
Commenced burning at — 2.30 P.M. — 10.1880

Removed to ~~[illegible]~~ chem. from organ with rise

Burned at per 7

At 12 noon

Total hours 48



621 Rec Brandlers Mr Butchelors horses ~~[illegible]~~ bench Mr.
R Butchelors horses pr tap hole
Rec. 150 } 780 11 1550
Commenced
Running at } at 7.00

March 24 Busted at clamps

~~[illegible]~~ 480 horses

Weather

1874 Found for Telephone room

when rent is ~~Exchange~~

Rec. 150

Commence Feb. 10 1880

Burning at 10.00

Have burnt – 200 hours

Moved to Chm over Jm Bailey

Cos Hook Feb 13 monitor

on shelf changed

Total 398 hours

Broken

629 Jon Mr. Batchelors Parlour 9

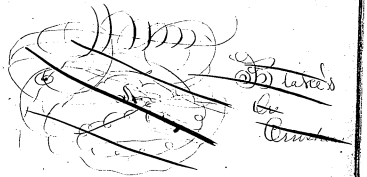
Rev. 150

Commenced mining at | Feb. 12 1880. at 6.40

Bonsted Boy jin

Burst ~~total hours~~ 29

Feb 15 1880



620 over Bimbis Bunds

Res. 680 ~ | Feb. 11 1880

Commenced | at 11½ P.M.
running at
Broke at Res. 9.
Burnt a total of 22 hrs
1/4
Total 38 hrs

457 Jno Jno Brown Dr
Pd. Second Domestic
Pd. Time
Commenced
Running at —

Feb 12 1880

Upto 7 at 8 ad. 5h 07.06

Deduct Second Time 110 —

Total 455 —

182 Mr Bartelow's cutting-room

A.R. No. 160 Have found - The cause was

caused 945 also took Time

Commenced Feb. 18 1880

Burning at

Up to Feb. 3 Time 945

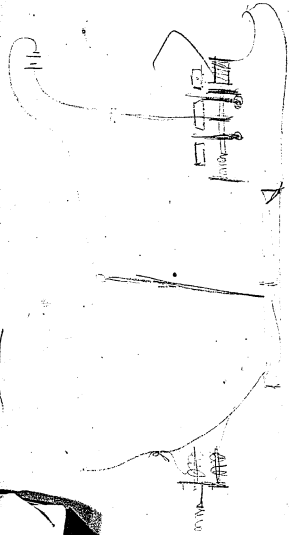
From " 3th 1h Time 110

Time — 455 Total

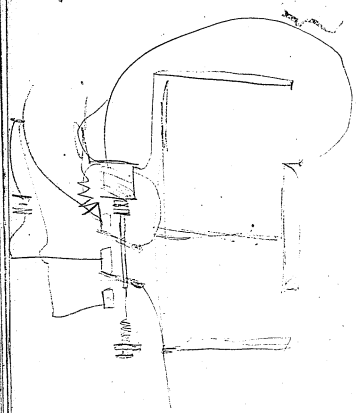
241 Jno Van Buskirk Dining room
Hot and cold time at 275 rds
Beds
Res 160

Commenced | Feb 12 1880
finishing at |

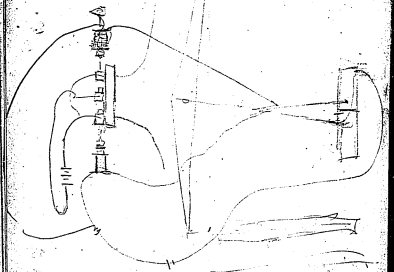
Hours Hunt from Bed 345 hours
" 12th — 110
455



409 Iron in Office Brought
560 hours moved over
to Mr Butchelors Desk
Feb 18 1880
Feb. 22. 1880 Posted at
Pos 6
Total hours 582



713 Jos Chum by organ Cab. 71
Sentto side Rm 143.
C.B. Tel. 23. ot 8 AM. Monday.
Reg. surgeon
Bad effect in carbon
Brought after to O.
Visited on 7 ot 24 1880
appro. ot quick.



114. for Chandelier. Hand from organ, south side

Rec. 136

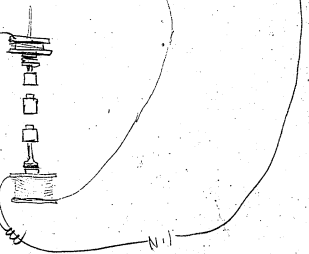
~~No 23 at 8.00 A.M.~~

Reg. engaged N E

Finished ~~at~~ 5.00 4

~~Total hours~~ 180

~~March~~ 4/1880



715 Jn Chandelier third from organ 75

Kathe oice Pleas 112

Com. burning at Feb. 23 8 P.M.

Reg engaged

Bonted at 1.30 Feb 25 1880

Total hours 30.30 Carbon Lasts

at pers. 5.

716 Chandelier fourth from organ
North side Res. 146

Com. burning Feb. 23 5 P.M.
Reg engaged

Posted at 8 P.M. March 1 1880

158 hours total time burned

696. On shore near organ, south side, (Langebnes)

Res. 136

Large bass fiber N. E.

Bruised Punch 3. Total lines

216 lines

Lamp first —
731 In front of Edisons house
Scotts aide
Feb 123

Commenced burning at 4 00 P.M. | Feb. 25 1880
Large Globes
N.E.

Pegged in at 5-5.C. Large Globe Glass
Bristol Punch 1 1880
Total hours 89 hrs

Lamp & post

732 Corner Plank walk & Wfo.

Rec. 135

Conv. running at 4.00 P.M.

Feb 25 1880

Large Globe

Use 5. Bil. Large trip

Bristol Feb. 27 1880

at 1200.

at 6.00 P.M.

~~26 Feb~~

Stater

733. Jn Direct = Lamp by corner of
Laboratory Yard Rec. 186
Cons. burning at FEB 25 1880
4.00 P.M. Large Globe

No 5 Sol. Large Crit. No 2.

March 4/25 186

March ~~25~~ Total hours 36½ hrs

1 pkt Fruit-cake Edisons factory 87

Recd 81

Burnt 114 hours } Jan 3 1880
Jan 3 1880 } Jan 3 1880 noon

Taken out by Customer
Jan 6 1881

Found in old book on Page 37
total hours burnt
put in the corner of plank walk
Total hours burnt 774 hours

Ups - on sheet - six errors / put -
ups without - recording
Jan 1881 Feb. 22 - (these above
figures are very nearly correct)

738 Lamps - found by the
corner of Mr Pitfatrick's yard
put up at Remarks On Shed
Feb. 22 4.00 -
Burn. burning | Buried Month 2 1880
Total ~~[illegible]~~ 104

736 another lamps found on
table marked 736 Buried
at pro. hat-dem. p.
Total Month 6

414 Jos Lamp-post between
corner Lamp-post of walk and
corner Lot. Bond

Put up about
Feb. 18 1880

Present about 480. lines in pave-
ment

Bonded on March 4 1880

730 Jn Chem 4y ogan anth
Dide Rec. 16.0
Commenced burning at 11.30 Feb. 26 1880 } Hammerto Plated on Draft of Carbon

Moved to Mr Batchelors Bench

Taken down to Mr B. Howe.

73 ~~Second~~ Chun Jun agm 75
with [illegible]

1 Feb 13 ~~8~~
Commenced
Running at
~~£~~.30 Hills 25 ~~Feb~~

Reg ~~Ord~~. Large bags
~~Standard~~ Ord.

Booked at pro. 1 ~~[illegible]~~
Total hours ~~[illegible]~~ 226

engine room

735 Jno Fred Chem. from organ 97
moth side
Rec. 137
Commenced
burning at —
4.30 Am Feb. 26

Reg. Large Carbon Proof
soaked in standard sol.
—
Feb 26. 1880 4.00 P.M. moved
to Engine room by smoking
room
Bursted by slamming door
March 3. 1880. Total hours 160
Carbon sealed at 6. P.M.

Bill for telephone rent

Bill for telephone rent over
twelve months ending 31st Jan 1880

Rec. for
Feb. 1880

Nil to present time has been
660 rent

Position ~~Direct bearings~~ ~~& 7~~
749 at Corner of Upstons yard
Rev 130 point ~~[illegible]~~ on Sheet.
March ~~[illegible]~~ 1880

Buried
Upon very Badly decomposed
Glass Tube.
M—

Position ~~X~~ Lamofpost ~~X~~ mpins
746 ~~Quotation dampers~~ corner

To 746 Burnt at Mp Tins
Rs. 147 corner for 20 hours
and brought back to Colombo
Taken out to office air
burnt 20 hours

Total hours 60 hours
Quotation buckled out letter
above shown.
Mr. Cartman says that
was dull red by hard contact
and then went out.

March 2. 1950

~~Position 8 Lamified~~

770 Upton's Hall -

Reg. 143 Commenced burning at 12 noon March 2 1880

Reg Carbon
& Standard 2d.

Burned

March 6 1880

~~Port~~ Lamsport — By Batchelors

764 Jno Williams Room

Res. on rock

March 2 1880 7.10 1880

Large loop Standard Nl.

769 Good Oven Dry Weak
Rec 173 Large globe and glass
Commenced burning at
March 3 1880

Large loop Standard Sch.

Bursted at March 5 4.30 P.M.

Glass broke by cutting wire
Carbons all in small pieces

Total 74 hours

#163 for Chandelier fluid from 111
ogdon with tube glass bell. large
P160

Con to Barron at | March 3 1880
8.50 P.M.

Large Lamp & 4 Otendical Ool.

Burners March 9 Total hours 121 —

Burners burned at per. 4 :

#163 B

767 Jos Stan. Batchelor sitting room Large Globe and glass

Born. Burning at — Res 163

March 8 1886 at 6.00 P.M.

Large lots $4 Dol.

Burnt 40 have tested between 70 5—

168 Jos Fox Potatoholes Hull

Large Fields Glass

March 3 1880

Rec'd 90

Commenced burning at Large Imp Standard Sol.

Jos B.
763 Jno Ow Butchelors Hunting —
worm
Rec. 176
Com. Sunny

Large bulb glass
Illinois 3 1850
6. P.M.

Large loop Standard Col. 4#

773 Mr Batchelor running — no 19
large bulb glass
Reo. 205
March 3 1880
Cond. burning
at 6.00 PM
Edisons Del. paper pressed
soaked and pressed again
— no
Burnt 40 hrs total

Notice —

756 Sent to John Francis
760 Steamer Gallia two
741 for himself and two
771 Jas H Johnson

1 March 2 1880

775 Jos Chem by my in north aisle
Res 210 Large B Glass
Cons to burn | March 8 1880
1.00 P.M.
Extract Solution Reg Porp
paper passed before and after
Soaking
March 11 still burning
165 hours
B Gome March 15, 1880

764 J. to Transport Schreen
Shop and Lab
Corr. training { March 2 1880
Rec. 167 at { at 6.00 P.M.
Reg Cabon ~~Otherwise~~

Finished March 13 1880
180 hours —ie—

788 In Wind from organ
Res. 176 Small globe, glass needle
Small loop 0.5
Error March 4 at 10 — 1880
Taken down & turn to test — March 14

757 on Wand-Lands at-
reg. table

Com. Luming at	Res Munich 1880 at 4.00

Two Large Corp Standard Dec
Munich 4 - 66 lms

790 for chem (both sides) third 3/

from regan.

No.
Commenced
to burn

March 5 1880
at

~~Brooks~~

gone Brooks house
made of 18 sheets of
tissue paper tube
total time 24 —

783 for Brackett on Engine-
room

Rec 190

Commenced 8 turns | March 4 1880 at 3.30 PM.

Broiled glass carbon engaged immediately

785 Engine room for bracket —

R. 157

Corr. to burn { March 3 1880
300 P.M.

Glass broke carbon broke oil
to pincer Total burn 16.

782 In Engine-room in Breaks

Rev. 196

Corr. to Cma } March 3 1880 at 3.30 P.M.

Bnated March 13/1880

Total hours 96

181 Jos Mr Kraus Hall
Rec 149
Com'd bum

March 3 1880
d 3.00 P.M.

Went upstairs on Peach
Mr C. sings
at 7.00 this March 6 1880
blab bum

795 Exp. on Photometric
drop Stars
Res 190
Commenced March 5 1880
burning d- 7.00 A.M.
Small Drop Reg. Carbon

Put over Charlies Bench
Rec. 198
Put on at 6.00 March 8 1880
Large trop 1½ Frame out
and pressed together

Moved & dum. by again
and broke after turning
40 hours total Broke out
per ~~#2~~ pro. "

802 In hemisphere between copper Res. 96 of Herb. gland and plenth "

Commenced | March 4 1880
3.00 PM

to 6mm

Busted March 9 1880

Burnt 98 hours

803 Corner of plank walk

to depot

Rec'd 89

Commenced | March 4 1880
8.00 P.M.

to bus at

Boarded March 10 1880

Board Total hours 193 hours

142 Jos Chum. by pumps 1/2 5
Moved down stairs to exp. with
brought back and put on Stand B.
Bunks Thum 14.1880
1 Stated hours dd.

832 Given to Rev. Barker
839 to exp. with
724

March 12/1880

100 taken from B. House

Res 144 } March 14 1880
Com Stock } at : ____
Has burned

80
66
14

14

48

14)660
2

Res 400

704 on heading ones has 102 cm

Res. 400 burnt 502 horns still

Sept 5 March 18 ~~Burnt~~ Age 21 cm

705 on arm by Ngwaseepo

Res 225

table 502 horn still burning

March 18 Com. burning Age 21/1880

Bass Gibee 6th 10

1 7 12

9.40

Age 8 X 1880

104 —

502

270

872

31
18

23
5

18
15

90

18

270

Burned at clamp

Very bright — Spot —

7th horns blue

1066 Jn Chem. Fy organ
Rec Smith bldg

~~Aug 8 1910 Rec~~

C. B. Mary 8 6 P.M.

Paper cartons cut with over
mold with over platinum clamp
carbon loops holes drilled in
ends of them so that over ground go
through them

moved to over Charles
Bench carbon broke at
pod 6

Mary 12 5 80.

Total time found-the

Mary 18 all days 5. 00 P.M.
kept d.
14 X 5 = 70 hours to lose here.

1075 Jr Chan. ty organ
Rec North Side
May 8 8 P.M. C.B.

Platinum clamps very short
so would have to drill holes
in carbon carbon cut - in old
mold

1067 Over flames bench
Rec'd. Merrit organ
C.B. May 8 6.00 P.M.
Paper cartons cut in new
mixed with new bituminous
charcoal carbon have holes
drilled in ends of them
so screw would go through
both of them

1971 Second Chan. Iron organ
Northside
C.B. Thomy 8 11 am.

Copper clamps made same
as reg. platinum clamps
with emboss from next mold
Pass tube one side carbon
slipped on of clamp
Tube burns [illegible] ated-25

Up Chan. north side third
from organ
C.B. May 8 at 11 am.

copper clamps made very
short – so have to drill holes
in carbon for screw to go
through carbon from new
mold

166

Ground Glass behind pumps 167
Hammer has record Ac Rg No. 6

1878 Found on Mar. 19
organ glass. Stone chimney fixed
to side of house
~~Sept~~ May 14 1880
Copper chimney made new
short as would have to pull
boiler in cellar for never
to go through cellar door
Never used

1079 On main line

Rev

Com. running Sunday 13 1880

10.30 a.m.

Cord Carbon cut by Chas. Hunn on cabin machine this once one of the first three cut

Broke away 13 at —

Stood very high heat when motor was on track No. 380 broke during the experiment

Broken here —

1080. Cor Diam. Cross

Cor. Forming May 13 1880
10.30 A.M.

Hard carbon out by Chas.
Klein on case indicating
one of first time

Birke here after forming
Started at 6.00 P.M. other
forming order on railroad
blue line 5 hrs. very fair
gel. down slowly off scale

1095 Brass floor Burnt to Hotel
Rev 143 gave Broker by lending
twice Thirty candles
May 24 1880

1096 Bass fiber Burnt - to burn
Res 140 Cracking across glass cracks
carbon wholes in bulb
Thirty candles
May 22d 1880

1098 First - one on main line
125 Jim front - door

Com. to run 9 P.M.

May 24 1880

T. Ruby - candle power

Bro fiber cocoa nut - shell
clumps are not of fiber

Burned 2 - 1.10 [illegible]

1 + 2.20 [illegible] 2.0 hours 20 mins

turned very fine on side
and broke immediately

Glass broke by one of
Pending wires

108½ second one on [illegible] 2nd
140 from first-class
Corn & [illegible] 9.30 P.M.
May 24
Bass Fiber cocoa nut-shell
on ends of fiber
30 candle power
Posted at camp [illegible]
10.30 [illegible]

1094 third one on main line

1289 in front-door

Com burning 9 30 PM.

Rusty candle fork —

1 Bass fiber cocoanut shell

clamp to fiber

1086 7 outer one from front-door
135 on inner door

Com. burning 8 P.M.
Delay. 24

Bass fiber covered-
shell on end of fiber
Burly Candle power

Bracket at 15 Am
4 hours burning

Inside glass cracked
at ~~Burn~~ burning
hours

78 2
32
6

8
5 178
8
40
32
12

15 4
9
135
32
167

1082 In Lawson's Room

145 May 24 Sat - 8 P.M.

Imbry Candles Jones

Bass fiber cocoanut - oil

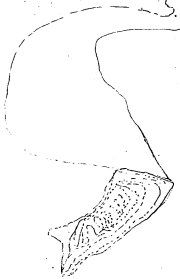
on end of fiber

Tuber Tube has only

to cover Bottom of

90 Am. < [illegible]

Total time



13
13
39
13
169
144
121

Half size lamp
400 hrs

$\boxed{40 \text{ Ohms}}$

154
51
51
51
255
2605
44
10420
10420
114620
10 | 2865
2800 | 2860 = 11
28
50

12 per H.P.

2200
6250
6290
6250
1550

2) 22870

114.35

) 334

711

114

2.0453
2.0453
1.6464
7.9431

3.6801

4790) 4.5195

.8394

6.18

7 for H.P.

16
5.3
21.3

21.3
7
149.1

150 candles for H.P.

Sep 20 1880

first boiled linseed oil
Tile stuff then boiled
with Asbestos mixed and S.G.

~~boiled linseed oil~~

Asphaltum 3
Paraffin .5
more linseed oil 5.5
back and more Asphaltum
M.G.

Linseed oil boiled
Asphaltum
Asbestos

K.G.

27 parts oil of cotton
80 parts oil of tar } heated together in a cauldron 180°C.

20 parts linseed oil
12 " sulphur
5 " wax of paraffin } 6 hrs 150°C

104

$\frac{1}{5}$ $\frac{27}{1}$

$\frac{27}{5}$

5 : 2/5 - parts of oil
6 . oil tar

12

$\frac{44}{5}$

2

6 linseed oil
2 2/5 - sulphur
wax paraffin

Bollino

Naphalin O.K.

Camphor

Poly charm O.K.

Glycerine

~~[illegible]~~

~~[illegible]~~

Chorofom

12 linseed oil
4 9/5 Dulphine
1 Boxes & paraffine

Trees:

Mississippi

Mississippi

Mississippi

150

9

5) 1350

230

92

262 tar

Arbeitsraum

Grm. 100 asphaltum X

" 60 resin X

" 20 beeswax X

" 20 caoutchouc

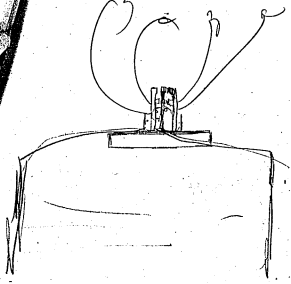
" 160 linseed oil

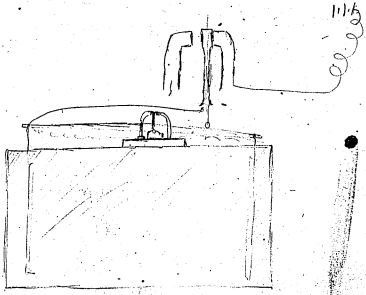
" 24 litharge X

" 30 Ox. Magn. X

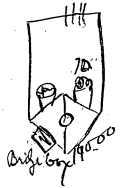
" 10 Borax X

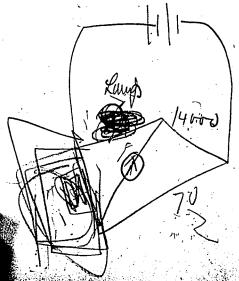
" 10 Lime





20) 10000 (50
10000
0





100
~~200~~
~~400~~
~~800~~
~~1600~~
~~3200~~

100
200
400
800
1600
3200

3200
1600
4800
5000

6300
3
12900

Jehl
3200
3200
6400

Jehl
Will you
Will you go to
the house

33 left Right -
31 " left - not perfect - good

Lamp 246 R
243 L

Battery L 33
R 33) OK
coin

20) 200 (10 10 / 2160

2160

20) 240 (12

4

12
108
96
12
1296
20
25920

108

2

1,08
20
21,60

216

3

32) 200
64) 270 (4.2
256
140

2 21.6
4.2
432
864
90.72

No 1 first - 256 fee ~~256~~
No 2 first - 254 " 250
No 3 first 267 " 259
~~No 4 first 223 " 2~~
No correct - reading

No 5 - first 249 fule 5 288
No 6 " 268 " 263 ~~4~~ 263
7 " 270 " "
203

216 2 217

216

Area #

	12		34		56		78	
	N							
Feb 4	11	00	11	00	10	00	11	00
5	22	00	6	00	0	00	22	00
6	22	00	9	00	[illegible]	00	18	00
7	11	00	10	00	[illegible]	[illegible]	[illegible]	[illegible]
7	11	00	3	00	[illegible]	00	[illegible]	00
8	22	[illegible]	2	00	21	00	[illegible]	00
9	11	00	[illegible]				2	00
							20	

Book 100 or 200	Page	Book 300	Page	Book 400 or 500	Page	Book 500	Page	Book 600	Page	700	Page
255	49	311	99	461	15	562	1	619	45	713	71
152	65			465	17	581	3	618	47	714	73
241	67			474	57	578	5	621	50	715	75
194	87			~~649~~	~~59~~	576	7	629	59	716	77
				457	63	579	9	620	61	731	81
				409	69	575	11	696	79	732	83
				414	91	557	19			733	85
						547	23			736	89
						574	25			730	93
						580	27			734	95
						593	29			735	97
						594	31			749	101
						592	33			746	103
						595	35			770	105
						578	37			764	107
						534	39			769	109
						529	41			763	111
						597	43			767	113
						586	51			768	115
						621	53			763	117
										773	119
										775	123
										782	125

273

1 Broke in log carbon
✓2 Clear glass broke piece out
3 Carbon broke to pieces from clamps
✓4 glass broke - clear glass
✓5 clear glass broke
✓6 clear glass broke
✓7 clear " "
8 carbon broke at clamp - white around wire
9 carbon broke - clear glass tit
10 carbon broke, clear glass big tits +il
11 carbon " " " "
12 carbon " " "
✓13 clear glass broke
14 carbon broke clear glass tits
15 carbon " " " "
16 " " big tit
17 " " tits
18 " " at clamp — tits
✓19 glass broke clear glass tits
20 carbon " " "
21 carbon broke, white around wire
22 " " " clear glass tit
✓23 glass broke - white around wire
✓24 " " "
✓25 " " "
26 carbon buckled - clear glass tits
27 " " white around wire
28 " " "

29 carbon buckled - white around wire 273
30 " " " "
31 " " clear tit
32 " " "
33 " " "
34 " " white around wire
35 " " clear tit
✓36 clear glass broke — clear tit
37 carbon broke — white on wire
38 carbon broke — "
✓39 glass broke — "
40 carbon " clear glass
✓41 glass broke white on wire
42 carbon " "
43 " "
45 " "
46 carbon broke "
47 "
48 carbon broke clear glass
49 " "
✓50 glass broke - white on wire
✓51 " "
52 carbon broke - enamel's big clear glass
53 " " white on wire
54 carbon broke - white on wire
55 " " " "

56	Carbon broke	- oc -	white on wire
57	"	"	"
58	"	"	"
59	"	"	"
60	"	"	"
61	"	"	Clear glass
62	"	oc	white on wire
63	glass -	oc	——
64	"	oc	"
65	"	Clear	
66	Carbon	"	
67	"	oc -	white on wire
68	"	Clear glass -	
69	glass broke	"	
70	Carbon "	"	
71	glass oc		white on glass
72	Carbon broke oc		
73	- "	"	
74	glass,	oc -	"
75	Carbon broke -	Clear glass	

76	- Carbon broke	Clear glass	
77	"	"	
78	"	Enamelled top	
79	"	Clear glass	
80	Carbon broke	-	"
81	- glass "	Enamelled top	
82	Carbon "	"	
83	"	"	Clear
84	"	"	Clear
85	glass broke —	Enamelled top	
86	- Carbon broke	- Clear glass	
87	- "	"	Enamelled top
88	glass broke	— Clear	
89	Carbon broke	Clear	
90	glass broke	Clear	
91	"	"	"
92	"	"	"
93	Carbon broke	— clea	
94	"	"	"

95 – Carbon broke – Enameled top
96 " " Clear
97 " " "
98 " " "
✓99 glass broke – clear
100 Carbon broke "
✓101 – glass broke "
102 Carbon broke "
103 " "
✓104 glass broke – "
105 Carbon " "
106 " "
107 – " "
108 " "
109 " "
110 " "
111 " "
112 " "
113 " "
114 " "
115 " "

116 Carbon broke – clear
117 " "
118 " "
✓119 glass broke – "
120 Carbon broke "
121 " "
122 " "
123 " "
124 " "
125 — " "
✓126 – glass broke clear
127 Carbon " "
128 " [illegible]
129 " " clear
✓130 glass broke
131 — Carbon " "
132 " " "
133 " " "
134 – Carbon broke clear
135 — " clear
136 — " "
137 – Carbon broke clear
✓138 – glass broke "
139 Carbon broke "
✓140 glass broke DC
141 Carbon broke clear
142 " " "
143 glass broke DC

144 glass broke — Clear
145 " " "
146 Carbon broke "
147 glass broke "
148 glass broke - OC
149 " " Clear
150 " " "
151 — Carbon broke "
152 glass broke "
153 " " Clear
154 Carbon " Clear
155 — glass broke "
156 Carbon broke "
157 " "
158 glass broke "
159 " " "
160 " " "
161 " " OC
162 glass broke Clear
163 Carbon — Enameled
164 " Clear
165 " "
166 " "

167 · Carbon broke Clear
168 glass broke — "
169 " "
170 — " "
171 — " "
172 — Carbon broke - Clear
173 — Carbon " "
174 — " " Enameled
175 — " "
176 — Carbon " Clear
177 " " Enameled
178 " " "
179 " " "
180 — " " "
181 — Clear [illegible]
182 [illegible] broke Enameled
183 " " Clear
184 " "
185 glass [illegible] Clear
186 Carbon " Clear
187 " "
188 — " " — Enameled
189 — " " "
190 — " "
191 — " " Clear
192 — " " "
193 " " "

194 Carbon broke — Clear
195 — " — "
196 — " Enamelled
197 " "
198 — " "
199 " Clear
200 — " — Clear
201 glass broke "
202 — " "
203 Carbon Broke "
204 " "
205 — " "
206 — " "
207 — glass broke "
208 " " "
209 — Carbon broke "
210 — " "
211 — " "
212 — " "
213 — " "
214 — " "
215 — " "
216 — " "
217 — glass broke "
218 — " "
219 — " "
220 — Carbon broke "
221 — " "
222 — " "

223 glass broke Clear
224 — " "
225 — " "
226 — Carbon broke "
227 — " "
228 — " "
229 — " Enamelled
230 — " "
231 — " "
232 — " "
233 — " "
234 — glass broke "
235 — Carbon broke "
236 — " "
237 — " "
238 — " "
239 — " "
240 — " "
241 — " "
242
243
244
245
246
247
248

65
glass broke

241
65
176 — 65
Carbon — 65 glass

Thursday 11

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34

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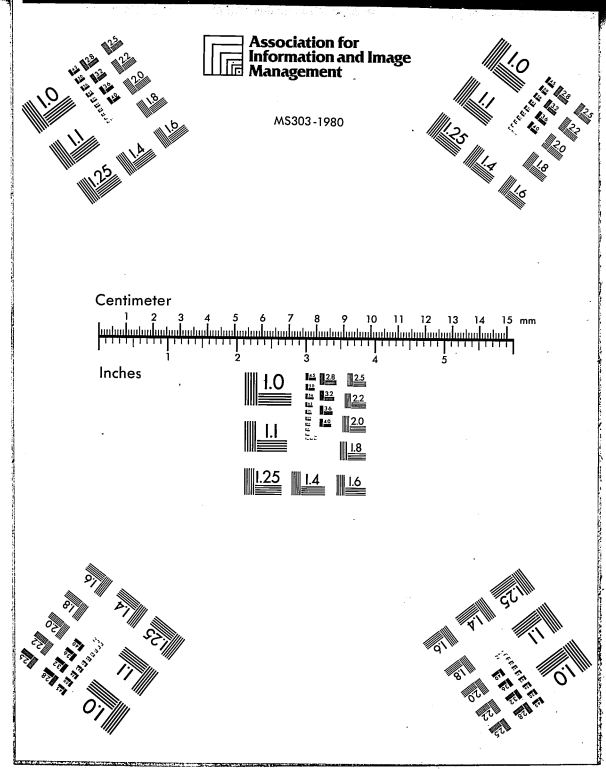
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